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# Connectionist Expert System for Medical Diagnosis using ANN– A case study of skin disease Scabies

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***Abstract- Today Skin diseases and lesions are the most common diseases that people suffer in different age groups. The paper presents the connectionist expert system for medical diagnosis of the most common skin disease – the Scabies using Artificial Neural Network (ANN) based classifier. The model has been implemented using Matlab. The system helps the medical professional in making effective treatment to patient, by reducing unnecessary cost.***

***Keywords- Artificial Neural Network, Expert System, Skin disease, Scabies, Back propagation algorithm***

## I. INTRODUCTION

The human expert performs the diagnosis of skin diseases by collecting patient records and complaints. This list of patient complaints and observed skin conditions are then expanded into several Boolean symptoms. The symptoms are further subjected to knowledge matching with the knowledge already possessed by the human expert (knowledge base-experience). If there is a match, the doctor recommends the disease as a possible skin disease. In some cases, the human expert may subject the patient to further laboratory tests in order to ascertain the causative agent of the skin condition. The test could serve as a confirmatory test if the disease diagnosed is actually caused by microorganism such as bacteria, mites, virus, fungi etc. In dermatology, more than thousand diseases have been identified. As General practitioners, family physicians, paramedical staff at primary health centers in rural areas encounters dermatological patients quite often in their daily clinical practice but are not able to diagnose skin diseases correctly, there is a need of an expert system for diagnosis of a skin diseases. Development of expert system that uses Artificial Neural Networks as knowledge base appears to be promising method for predicting medical diagnosis.

In [1] Bakpo and Kabari made a case study of the skin disease Scabies using Artificial Neural Network. The data used by them in implementation and testing of the ANN were collected from the National Skin center Singapore. The conditions they considered for diagnosis of Scabies were tiny bumps, itching, Scaly and symptoms on fingers etc. But such conditions cannot be generalized for under developed and developing countries. Usually tropical climate, poverty, poor personal hygiene, overpopulation and poor civic conditions are responsible for such disorders.

Scabies is an infestation caused by a mite Sarcoptes Scabiei or Acarus Scabiei as in Fig.1.

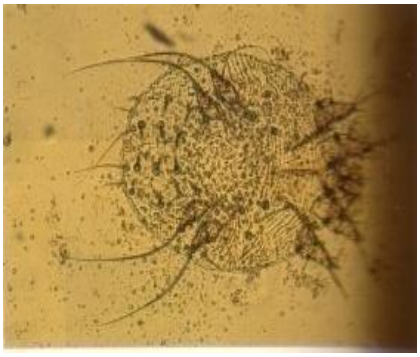


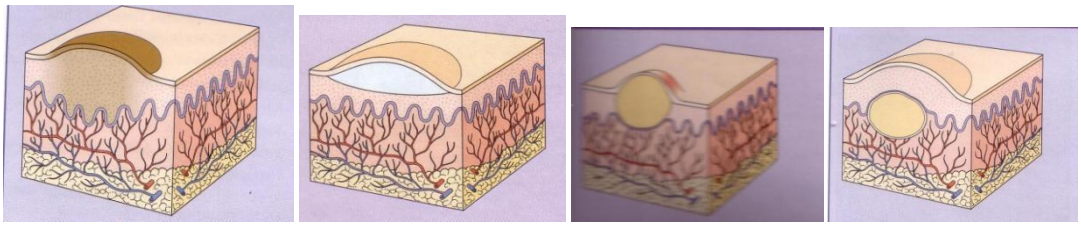
Fig. 1 (Sarcoptes Scabiei)

Commonly it is the hominis (human) variety of mite which is responsible but occasionally animal (dogs and cats) mites may produce the disease in human being [2]. The transmission is through close personal contact and the clothes and beddings. A patient of Scabies presents with a complaints of itching which is usually worse at night. The pathognomonic lesions are

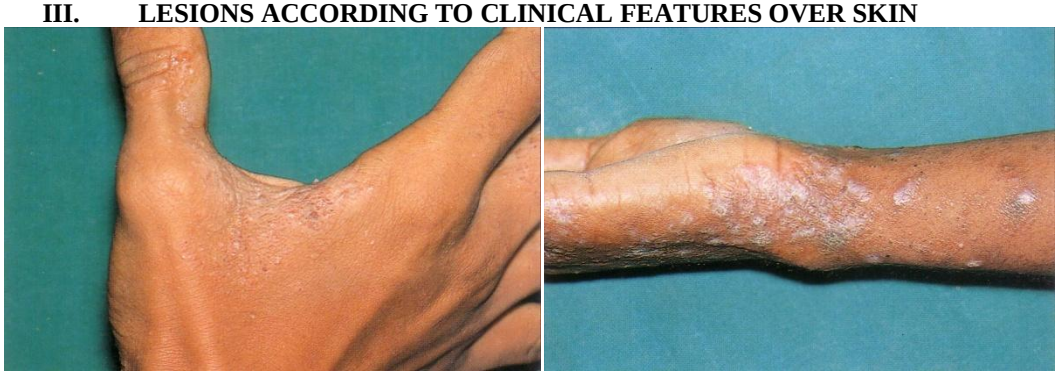
burrows which are usually seen on the sides of the fingers, wrists, male genitalia, areolae and nipples in women. The burrows are S-shaped, thread like, brownish lesions about a centimeter or so in length. Papules, excoriations, Vesicles and Pustules are seen commonly in the webs of the fingers, wrists, axillary folds, breasts in females, lower abdomen, thighs, male genitalia etc. [2] Fig. 2 gives ideas about Lesions in relation with skin internal structure and Lesions according to clinical features over skin. Diagnosis of scabies is based on presence of lesions at the classical sites, nocturnal(night) itching and usually a positive family history of similar disease.

## II. LESIONS IN RELATION WITH SKIN INTERNAL STRUCTURE



Papule Vesicle Pustule Nodule

## III. LESIONS ACCORDING TO CLINICAL FEATURES OVER SKIN



Burrows Papules and Nodules

Papules V esicles and Pustules

Fig. 2

## IV. THE SYSTEM

An expert system for diagnosis of skin disease using Artificial Neural Network (ANN) has been developed using Matlab. As a case study a skin disease Scabies has been considered. Based on conditions and symptoms as well as the suggestions from the leading dermatologist, the following conditions for diagnosis in under developed, developing and over populated countries have been considered.

1. Night itching
2. Family History
3. Burrows
4. Papules, Vesicles, Pustules, Nodules, Excoriations (Scratch marks).

## V. Rtificial Neural Network Classifier

Based on the computational simplicity ANN based classifier is used. The structure is shown in the Fig. 3.

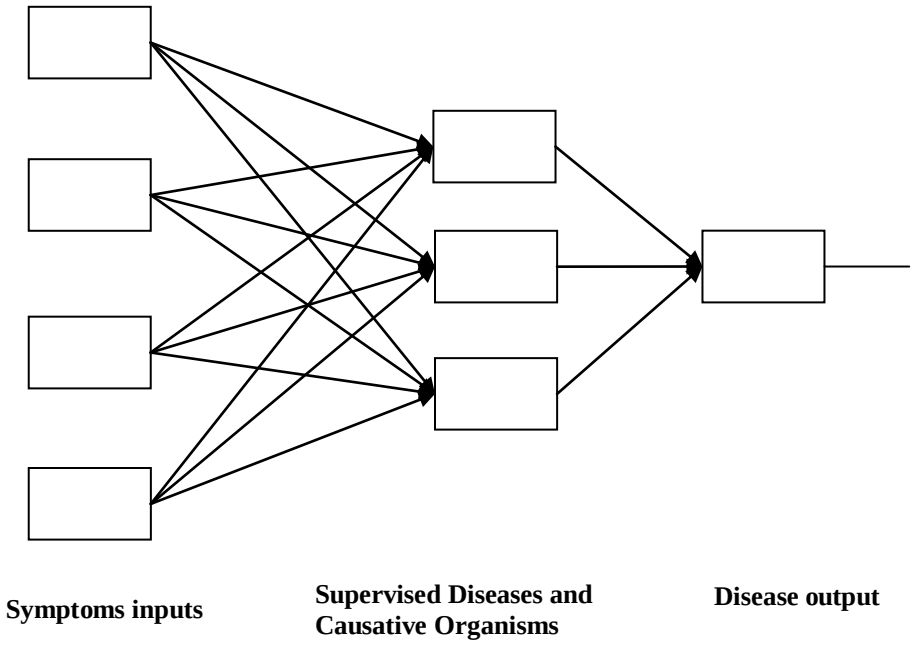



Fig. 3 (ANN structure for skin disease)

In the proposed system, a feed forward multilayer network is used. Back propagation algorithm is used for training the network. It has input layer, one hidden layer and output layer. The hidden and output layer nodes adjust the weights value depending on the error in classification. In Back propagation algorithm, the signal flow will be in feed forward direction, but the error is back propagated and the weights are updated to reduce error. The modification of the weights is according to the gradient of the error curve, which points in the direction to the local minimum. Thus making it more reliable in prediction as well as classifying tasks. In Back propagation algorithm, weights are initialized randomly at the beginning of training. There will be a desired output, for which the training is done. During the forward pass of the signal, according to the initial weights and activations function used, the network gives an output. That output is compared with the desired output. If both are not same, an error occurs. During reverse pass, the error is back propagated and weights of hidden and output layer are adjusted. The whole process then continues until error is zero. The network is trained with known values. After training, network can perform decision making. The Back Propagation algorithm is given in appendix. In this proposed methodology, four features were given as input to a multilayer feed forward network. There is a hidden layer with 3 hidden neurons. Output layer is with one output neuron. Sigmoid function is used as activation function at both the hidden and output layer which gives output as 0 or 1. 0 represents absence of Scabies and 1 represents its presence. For the proposed system, we define four symptoms as four input variables as given below. Night itching as $X_1$, Family history as $X_2$ , Burrows as $X_3$ and Papules or Pustules or Vesicles or Excoriations or Nodules as $X_4$. These variables can take binary values either 0 or 1. If symptom is present, the variable takes value 1 otherwise 0. The neuron is taught to fire (i.e. output 1), when the input string is 1111, 0010, 1100 or 0110 and will not fire ( i.e. output 0) otherwise.

The firing rule, which is very important rule and requires some higher level knowledge of the disease, is depicted in the Table I.

TABLE I
FIRING RULE

| | | | | | |
|---|---|---|---|---|---|
| $X_1$ | 1 | 0 | 1 | 0 | Output 0 in all other cases. |
| $X_2$ | 1 | 0 | 1 | 1 | |
| $X_3$ | 1 | 1 | 0 | 1 | |
| $X_4$ | 1 | 0 | 0 | 0 | |
| Output | 1 | 1 | 1 | 1 | |

The system has been implemented in Matlab. The data used in the implementation and testing of the ANN were collected from the leading Skin clinics of Vadodara, India.

The learning process proceeds by way of presenting the network with the training set composed of input patterns together with required desired response pattern. By comparing the actual output with the target output for given pattern, the error is computed using the back propagation algorithm given in Appendix - A. This error can then be used to alter the connection strengths between the layer s to achieve better network response to the same input patterns in subsequent iterations. In testing the diagnostic system, different tests were carried out at random using various symptom combinations and the results were compared with the expected result of the system. When there is a match, success was recorded and in the situations where there is no match, failure was recorded. Thus, the success ratio is 95%.

## VI. Conclusion

An expert system for diagnosis of skin disease using Artificial Neural Network (ANN) is proposed here. The system is implemented using Matlab and it achieves 95% success. Also, it provides great flexibility. With this flexibility, the level of coverage of skin condition by the diagnostic system is boundless. The proposed expert system will serve as an aid to medical professionals in recommending effective laboratory tests and treatments of disease. It helps patients in reducing excessive costs from unnecessary laboratory test and helps medical professionals in effective patient treatment.

**References**

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[2] Bajaj A K, Sharma Rajeev, Dhar Sandipan, " Dermatology, Leprosy and Sexually Transmitted infections " Jaypee brothers medical publishers (P) Ltd. , 2nd edition, 2005.

[3] Zurada Jacek M. , "Introduction to Artificial Neural Systems" , Jaico Publishing house, 2006.

## Appendix - A

### (Back-Propagation Algorithm)

The back propagation algorithm uses supervised learning, which means that we provide the algorithm with examples of the inputs and outputs. We want the network to compute, and then the error (difference between actual and expected results) is calculated. The idea is to reduce this error, until the ANN learns the training data. The training begins with random weights, and the goal is to adjust them so that the error will be minimal. The activation function of the artificial neurons in ANNs implementing the back propagation algorithm is given as follows.

Back-Propagation Algorithm:-

- We have inputs : $x_i\,'s$
- We want certain specific outputs : $d_j\,'s$
- $o_j\,'s$ are actually getting outputs
- $E_j\,'s$ are error i.e. obtained-desired
- $o_j^{'}s$ are actually getting outputs using initial guess of weights $w_{ij}\,'s$
- Then if error is more, weights are changed using $\Delta w_{ji}$ gradient descent method.

**Step 1:-**

First we calculate $A_j\,(\bar{x}\,,\bar{w}) = \sum_{i=1}^{n} x_i w_{ji}$

**Step 2:-**

Then the output is, $o_j\,(\bar{x}\,,\bar{w}) = \frac{1}{1+e^{A_j(\bar{x}\,,\bar{w})}}$, using sigmoidal function.

**Step 3:-**

Find error function for output layer for each neuron.

$$\boldsymbol{E_j(\bar{x}\,,\bar{w}\,,\bar{d}) = \sum (o_j(\bar{x}\,,\bar{w}) - d_j)^2}$$

**Step 4:-**

If the error is more than certain tolerance, the weights are updated using the method of gradient descent.

$$\Delta w_{ji} = -\eta \frac{\partial}{\partial w_{ji}} \{E_j\}$$

Where, $\eta$ is learning rate and $\eta > 0$ s constant.

 