# Ulcerative Colitis Diagnosis Based on Artificial Intelligence System

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## Abstract

Ulcerative colitis (UC) disease is irritation of the colon that is frequently related to infection and immune compromise. The wall of the colon with inflammation is always thicker than normal. UC may be life-threatening and lead to death if not detected early. Early detection of this disease is very important to initiate appropriate treatment. In this paper, the Artificial Neural Network (ANN) applied to detect the UC according to a theoretical dataset generated by the criteria of UC. The Levenberg-Marquardt (LM) algorithm has trained the single hidden layer ANN. The best behaviour is equal to $1.9947\times10^{-24}$for the system which the number of neurons =4.

Keywords:- ANN, UC, Dataset, Daises Diagnosis.

## 1. Introduction

Researchers and scientists have tested numerous experiments and examine regarding UC diagnosis due to its effect by infection and immune compromise, in which the early detection of UC is important because it reduces the severity and duration of the disease [1]. UC is a potentially debilitating and life-threatening inflammation of the inner lining of the colon and often results in abdominal ache and diarrhea. Common causes of UC include viral or bacterial infection, ischemia, or Inflammatory Bowel Disease (IBD) [2]. ANN was stimulated from the biological human neural networks, which can process linear and non-linear behavior. The flexibility and the advantage of parallel data processing make it distinct in many areas including the medical field. ANN is appropriate for different systems due to the factors in the model are dynamically changing [3]. In other, it was not requiring complex process algorithms or highly sophisticated statistical for training the network.

ANN has been used in many scientific works to solve the problem with high accuracy [4]. A number of researchers have offered different methods in the field of diagnosing diseases as shown in the following: Ashok Dahal et al, in 2015, present a video frame method to detection and diagnosis UC disease based on a hybrid approach in image textures. The accuracy of this method is more than 90% [5]. Joseph Finkelstein et al, in 2009, introduce a comprehensive medical system to help the infected people with UC in terms of monitor symptoms, medication compliance and the weight changes based on a laptop computer connected to a phone line [6]. Jiamin Liu et al in 2016, used a Regional Convolutional Neural Network (R-CNN) in UC detection based on Computerized Tomography (CT) scans. The achieved sensitivity of the network is 85% [7]. Michael T. McCann et al in 2012 used a set of features, easily understood and fast to compute in a colon biopsies image to identify UC [8].

Hirokazu Nosato et al in 2014, describes a manner for UC diagnosis based on image processing, which used recognition techniques for colonoscopy images with a multi-discriminant analysis in order to assign the type of UC. The accuracy rate of the diagnosis system is 98% [1]. Zhuoshi Wei et al in 2013, present a method to detect the UC in abdominal CT scans based on image processing. In order to assign the UC regions used visual codebook. The sensitivity of the system arrived at 73.3% [9]. In this paper: generate data set from the UC criteria to diagnosis the disease. Based on the pre-trained ANN, the status of the patient has been given. LM used as a method to train the ANN.

## 2. Neural Network Technique (Nn)

ANN is a signal processing system inspired by the simulation studies on the behavior of the human brain. ANNs are computational tools to take its decision based on its supervised learning from its training process [10] . Back-Propagation (BP) is the widespread method for the training part of the ANN. The work of the BP method as its name, in which the weight values are updated iteratively until the best value is reached [11]. Training completed when the error arrived at the minimum value. The error is the difference between the actual and desired outputs [12]. Several sub-methods are derived from the BP methods such as Gradient Descent (GD), Resilient BP (RPROP), Gradient Descent with Momentum (GDM), Gradient Descent with Momentum and Adaptive Learning Rate (GDX), Conjugate Gradient Descent (BP), Conjugate Gradient Fletcher– Reeves (CGF), Conjugate Gradient with Polak–Ribiere (CGP), LM and others. These sub-methods are distinct in the calculating error and factors that affected the process of updating weights [13]. The general mathematical model of update weight for the feed-forward BP methods presented in Eq.(1-16) [11] [14] and [15]. The general architecture of the artificial system presented in Figure (1).

$$y = \mathrm{f(net)} \quad \ldots(1)$$

$$\mathrm{net} = w_1x_1 + w_2x_2 + w_3x_3 + \cdots + w_nx_n \quad \ldots(2)$$

$$\mathrm{MSE} = \frac{1}{2}\sum_k (d - y)^2 \quad \ldots(3)$$

$$g = \frac{\partial(\mathrm{MSE})}{\partial w} \quad \ldots(4)$$

updating weight of GD method:

$$w_{t+1} = w_t - a\, g_t \quad \ldots(5)$$

updating weight of RPROP method:

$$\Delta w_t = \begin{cases} -\Delta_t & \text{if} \frac{\partial E}{\partial w}(t) > 0 \\ \Delta_t & \text{if} \frac{\partial E}{\partial w}(t) < 0 \\ 0 & \text{else} \end{cases} \quad \ldots(6)$$

$$w_{t+1} = w_t + \Delta w_t \quad \ldots(7)$$

updating weight of GDM method:

$$w_{t+1} = w_t - \alpha\, g_t + \mu w_{t-1} \quad \ldots(8)$$

updating weight of GDX method:

$$w_{t+1} = w_t - a_{t+1} g_t + \mu \quad \ldots(9)$$

$$a_{t+1} = \gamma\, a_t \quad \ldots(10)$$

The updating weight of Conjugate Gradient Descent BP methods

$$p_0 = -g_0 \quad \ldots(11)$$

$$p_t = -g_t + \beta_t g_{t-1} \quad \ldots(12)$$

$$w_{t+1} = w_t + a_t p_t \quad \ldots(13)$$

updating weight of CGF method:

$$\beta_t = \frac{{g_t}^T . g_t}{{g_{t-1}}^T g_{t-1}} \quad \ldots(14)$$

updating weight of CGP method:

$$\beta_t = \frac{{\Delta g_{t-1}}^T . g_t}{{g_{t-1}}^T g_{t-1}} \quad \ldots(15)$$

updating weight of LM method:

$$w_{t+1} = w_t - [\, J^T J + \zeta\, I\,]^{-1} J^T e \quad \ldots(16)$$

**where:**

y: The output of the neuron. f: The activation function. x: The input signal. w: The weight. n: The number of inputs to neurons MSE : The Mean Square Error. k: The No. of output neuron. d: The output target vector. g : The gradient of the MSE with respect to the weight. a : Learning rate.$w_{t+1}$: The new weight vector. μ : The momentum constant. $\beta_t$: Constant value varying with various types of conjugate gradient methods. w is the weight, J is the Jacobian matrix, ζ is a combination coefficient. e is a vector of network errors.

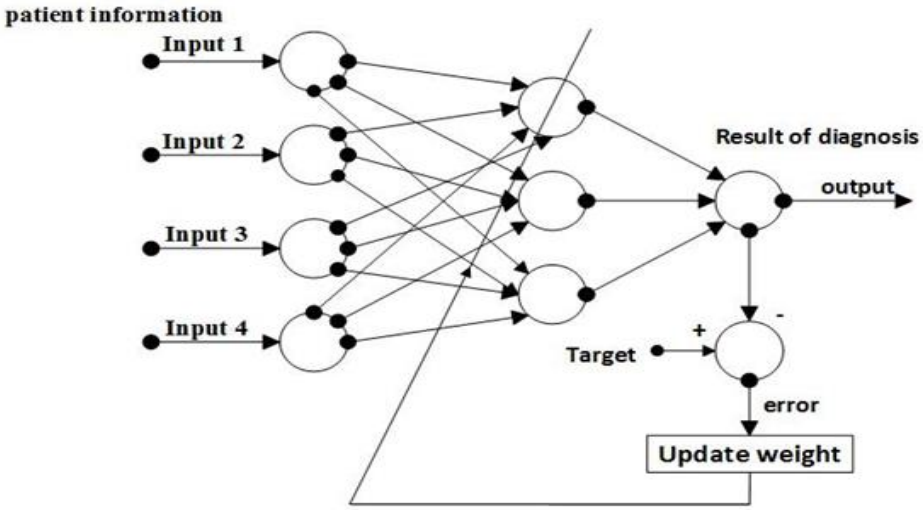


**Fig. 1. The architecture of neural system.**

## 3. Ulcerative Colitis (Uc)

UC is a type of IBD characterized by non-persistent inflammation of the surface layer of the mucous membrane of the colon with the formation of ulcers in this layer and can affect the disease chronic all ages, which can be UC is life- minatory. Doctors classified the disease into four categories as:

1 - Chronic inflammation that sometimes activates and inhabits in 70% of cases.

2 - chronic inflammation worsens continuously without periods of improvement in 10% of cases.

3- Very severe inflammation with colorectal UC in 10% of cases.

4 - The rest of the patients have a single bout of inflammation that leads to a kind of immunity with no return of the disease **[16]**. Knowing the signs, symptoms and diagnosis of early UC can lead to faster treatment.

## 4. Dataset Criteria and Training of UC

A database is an important factor to detect diseases because it can provide time and accuracy advantage based on resources of other works. In this work, the criteria of UC have contained four factors: colic, diarrhea, bleeding and anemia. These indicators are important for UC detection by the computer-aided system.. The Criteria is show the symptoms of the disease the first symptom is colic in the milled stage of the disease. In the second stage (moderate) the symptoms have become colic with diarrhea. In severe and a very severe stage will appear blood mix with bowel may be seen that or by test in the lab. When bleeding detects early and stops by treatment will be don't leading to anemia .if not the patient will be decrease the level of (HB) (anemia) and when to stay the anemia will lead to the hypovolemic shock and death. The system gives an assessment of the level of the disease according to the input information of the patient [17].

## 5. Result And Discussion

For the ANN topology, the initial weights for the neuron are assigned randomly. The dataset divided into three parts in the training process: 70% for training, 15% for testing, and 15% for validation. The dataset includes 64 rows to cover all the outcomes. The seven sub-algorithms are tested to give the

best training results. Table (1) presents the minimum MSE of each method described in section two with the suitable size of the hidden layer. The LM gives the best classification accuracy with four neurons in the hidden layer that provide a suitable complexity and accuracy as shown in Figure (2). The best Mean Square Error (MSE) for validation performance =1.9947×10-24 as presented in Figure (3). This performance is suitable in comparison to other works presented in section one. The amount of curvature, smoothness, and serial decrease without zigzags indicate good training. Figure (4) indicates the effectiveness of the network training by the equality between the actual output and the target, which the correlation between actual output and the target are presented in four sub-regression curves for training, validation, test and these combined in the fourth.

**Table (1): the MSE with the structure of neural network mehtods**

| Sub-algorithm | No of hidden layer | MSE |
|---|---|---|
| GD | 3 | 0.0017 |
| GDM | 6 | $5.5688\times10^{-09}$ |
| GDX | 5 | $4.3001\times10^{-05}$ |
| Rp | 6 | $4.3610\times10^{-09}$ |
| CGF | 6 | $7.2843\times10^{-10}$ |
| CGP | 5 | $3.8599\times10^{-10}$ |
| **LM** | **4** | $\mathbf{1.9947\times10^{-24}}$ |

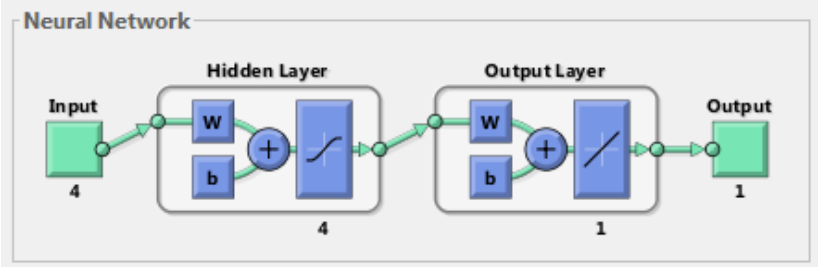


**Fig. 2. The blockdiagram of the ANN.**

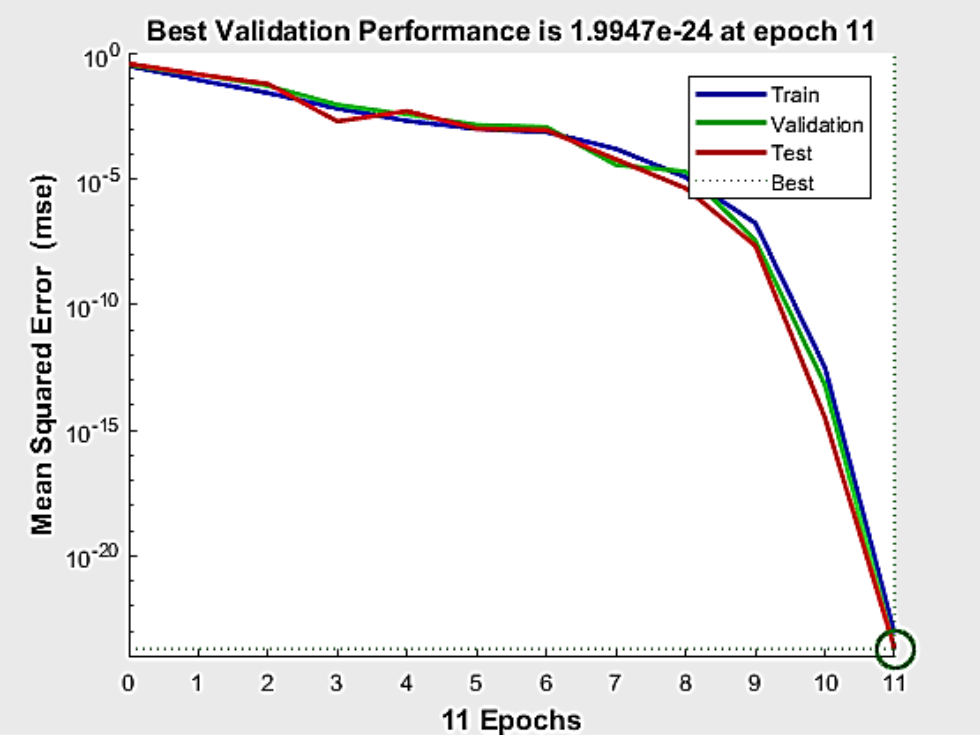


**Fig. 3. The MSE performance curves.**

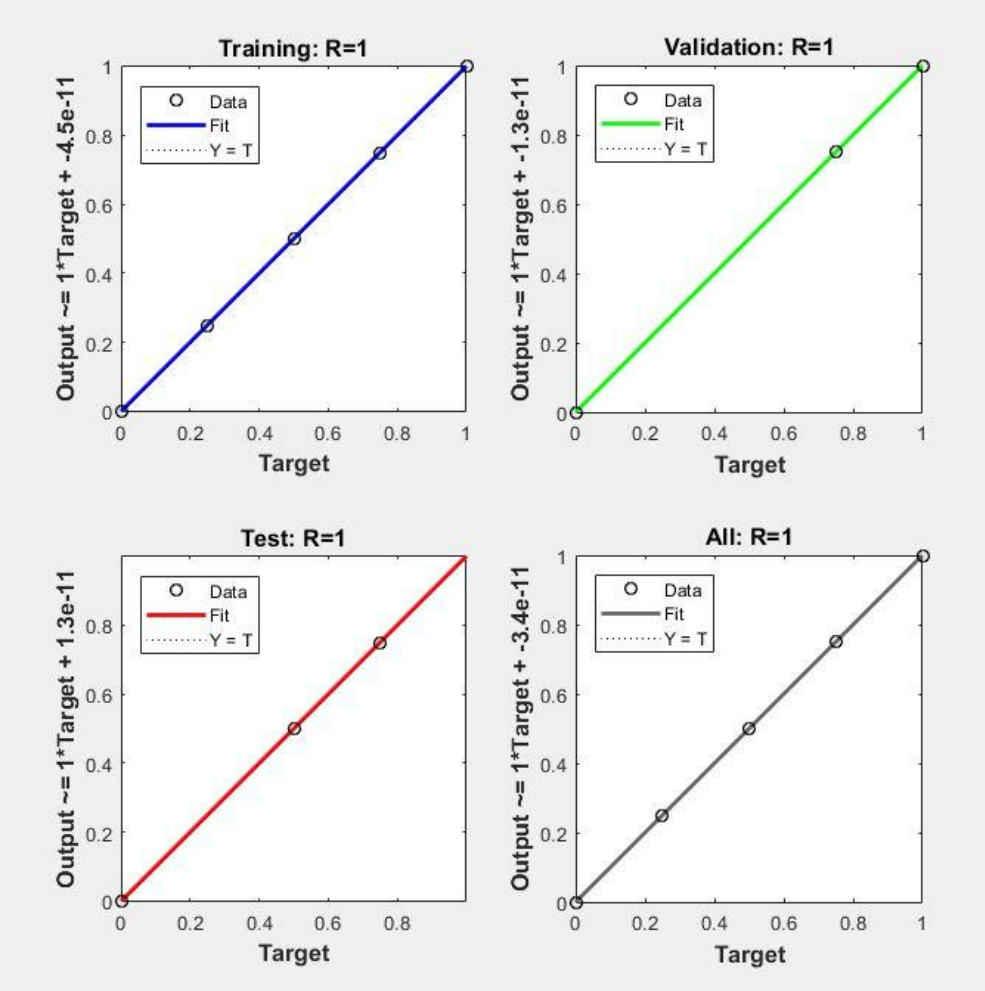


**Fig. 4. The regression curves.**

## 6. Conclusion

The active diagnosis of UC disease is implemented using ANN by simulation with Matlab. In general, it is very difficult to assess the severity of UC seriously because the symptoms are usually unintegrated and different patterns. The results show that this method has several advantages such as speed in finding results in the shortest possible time, as well as high accuracy(MSE=$1.9947\times10^{-24}$ contains 4 neurons in hidden layer), which helps in the early detection of UC disease.

### Conflicts of Interest

The author declares that they have no conflicts of interest.

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# تشخيص التهاب القولون المزمن بالاعتماد نظام الذكاء الاصطناعي

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**الخلاصة**

مرض التهاب القولون التقرحي هو تهيج في القولون الذي يرتبط في كثير من الأحيان مع العدوى ونقص المناعة. يكون جدار القولون للشخص مصاب بالالتهاب دائمًا أكثر سماكة من المعتاد. قد يكون مرض التهاب القولون التقرحي مهدد للحياة ويؤدي إلى الموت إذا لم يتم اكتشافه مبكرًا. الاكتشاف المبكر لهذا المرض مهم للغاية لبدء العلاج المناسب. في هذا البحث، تم تقديم شبكة العصبية الاصطناعية للكشف عن مرض التهاب القولون التقرحي وفقًا لمجموعة البيانات النظرية التي تم إنشاؤها بواسطة المعايير. تم تدريب الشبكة باستخدام خوارزمية Levenberg-Marquardt. أفضل اداء للشبكة كان حيث نسبة الخطأ تساوي $1.9947\times10^{-24}$ للنظام الذي عدد خلاياه العصبية = 4.

**الكلمات الدالة:** شبكة الذكاء الاصطناعي، التهاب الكلية المزمن، قاعدة بيانات، كشف الامراض.