

A fuzzy logic based approach for prediction of basal cell carcinoma and squamous cell carcinoma among the data of skin cancer

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Abstract

INTRODUCTION: Both basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) is a type of skin malignancy which are deadly in nature. Although both can cause a serious setback for the human body, SCC is most dangerous as per human life is concerned.

OBJECTIVES: It is necessary to spot out the cases of SCC and BCC among various data of skin cancer. In this research, the same is spotted out with the help of the fuzzy logic system.

METHODS: At first, the membership function is constructed from the input data provided. Then based on the generated membership function, a set of fuzzy if-then rules are created. The outliers from the source data are also removed before the generation of the fuzzy membership function. Based on the fuzzy if-then rules, the decision, whether the case is of basal cell or squamous cell carcinoma is taken.

RESULTS: The output prediction by the system is compared with the actual pathological report of the patients. The comparison provides an accuracy of 94.94 percent.

CONCLUSION: This paper introduces a new technique to predict the existence of multiple cancers (either basal cell or squamous cell) from the mixed cancer dataset. The outcomes of the examination on the source dataset show that the proposed system achieved extraordinary desire accuracy for the portrayal of squamous cell carcinoma and basal cell carcinoma.

Keywords: BCC, SCC, creatinine, membership function, fuzzy system.

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1. Introduction

Skin malignant growth is the most widely recognized of every single human disease. More than 10 million individuals throughout the world determined every year to have some kind of infection. Skin disease happens when typical cells experience a change and develop and increase without ordinary controls [1]. Basal cell carcinoma and squamous cell carcinoma are the two most normal kinds of skin malignancies. Basal cell carcinoma (BCC) happens all the more frequently, assuming acknowledgment for about 80% of these cases. Basal and squamous cell skin tumors are the most well-known sorts of skin diseases. They start in the top layer of the skin (the epidermis) and are frequently identified with sun presentation [2]. Basal cell carcinoma starts in

the basal cells: a sort of cell inside the skin that produces new skin cells as old ones cease to exist. Basal cell carcinoma frequently shows up as a marginally straightforward knock on the skin; however, it can take different structures. Basal cell carcinoma is a moderate developing malignant growth that only sometimes spreads to different pieces of the body [3]. Basal cell carcinoma happens when one of the skin's basal cells builds up a transformation in its DNA. Most basal cell carcinomas are believed to be brought about by long haul presentation to bright (UV) radiation from daylight and business tanning beds. The manifestations of basal cell carcinoma once in a while take after the highlights of non-dangerous skin conditions, similar to psoriasis or dermatitis. This kind of skin malignancy shows up as an anomalous, uncontrolled development or injury on the skin. Basal cell carcinomas frequently look like open wounds, red patches, pink developments, glossy knocks, or scars. Basal cell

carcinomas infrequently spread (metastasize) past the first tumor site to become hazardous [4]. There are a few basal cell carcinoma treatment alternatives accessible to patients, including Mohs small scale realistic medical procedure, extraction medical procedure, electro-medical procedure, cryosurgery, and laser medical procedure. For patients with basal cell carcinoma, there is another choice: Superficial Radiotherapy or SRT, the non-careful basal cell carcinoma treatment decision for expelling non-melanoma skin malignant growth [5]. Squamous cell carcinoma (SCC) creates in the slight, level squamous cells that make up the external layer of the skin. Squamous cells are discovered everywhere throughout the body, and this sort of malignant growth can happen anywhere squamous cells are found. Even though this type of skin disease isn't typically dangerous, one significant distinction between the basal cell and squamous cell malignant growths is that squamous cell tumors are bound to become further into the layers of your skin and spread to different pieces of the body. While still moderately exceptional, it is viewed as a forceful type of malignant growth, whenever left untreated [6]. Squamous cell carcinoma is the second generally incessant of the keratinocyte-inferred malignancies after basal cell carcinoma and is related to a huge psychosocial and financial weight for both the patient himself and society. Announced hazard factors for the dangerous change of keratinocytes and advancement of SCC incorporate bright light presentation, trailed by constant scarring and irritation, introduction to concoction mixes (arsenic, bug sprays, and pesticides), and resistant concealment [7]. One of the genuine risks of this neoplasm is that in its beginning periods, it can go unnoticed. For the most part at the underlying stages, it is effortless yet may build up a consuming sensation of agony when it is progressed. Basic destinations for SCC to create are on the tongue, lips, and floor of the mouth. Some SCCs emerge in evidently typical mucosa; however, others are gone before by clinically clear threatening sores, particularly arthroplasty and leukemia. Normally, SCC shows as an ulcer with fissuring or raised epiphytic edges. It might likewise present as an irregularity, as a red sore (erythroplakia), as a white or blended white and red sore, as a non-mending extraction attachment or as a cervical lymph hub development, described by hardness or obsession [8]. Squamous Cell Carcinoma is a disease that starts in squamous cells, which are slender, level cells that resemble fish scales. Squamous cells are found in the tissue that structures the outside of the skin, the coating of the empty organs of the body, and the entries of the respiratory and stomach related tracts. It is also known as epidermis carcinoma. It happens because of the keratinization of the epidermal cells and can metastasize to different locales of the body. The introduction of squamous cell carcinoma can happen on any region of the body, yet is generally normal in regions that are habitually presented to bright (UV) radiation, for

example, the ears, lips, face, neck, head, arms and legs [9]. Squamous cell carcinoma is the aftereffect of delayed introduction to bright (UV) radiation from the sun or tanning beds and lights. Different causes may include reasonable skin, a background marked by burns from the sun, individual history of precancerous skin injuries or skin disease, or a debilitated safe framework. The indications of squamous cell carcinoma frequently show up as flaky, aggravated skin, or raised developments like moles. When all is said in done, any adjustment in previous skin development, for example, wounds or injuries that neglect to recuperate, or the advancement of new developments on the skin, ought to be counseled on with a specialist right away. Squamous cell carcinoma treatment relies upon the size, area, and forcefulness of the tumor. Customary treatment choices - including Mohs - have included obtrusive entry points that slice through sound tissue, prompting a long recuperation and unattractive scarring [10]. To differentiate between BCC and SCC, the fuzzy logic system plays a vital role. With the help of fuzzy systems, the prediction of BCC and SCC among skin cancer patients becomes quite easier. Fuzzy sets and instruments are significant in portraying the essential information component of the outside world by the utilization of phonetic factors and etymological qualities. A few delicate registering strategies have been made for coordinated AI frameworks. The assurance of the fitting framework is critical and has been a test among the researchers in making and completing the disorders end structures. Furthermore, these delicate processing procedures can be used to orchestrate the afflictions through a ton of authentic educational records. In this manner, to build the expectation precision a fuzzy rationale approach [11] is utilized. The cancer patient's data for our research work was collected from "111 Save Life Hospital", Jamshedpur, Jharkhand, India. After removing the outliers from the data set, the membership functions (for the same data set) were constructed with the help of the approach described in [12]. On the basis of newly constructed membership functions, a set of fuzzy if - then rules were created for the prediction of the output from the fuzzy logic system. The predicted output is compared with the original output (given by the biopsy report of the patient) and the system's accuracy and the error rate is calculated.

Our exploration work currently continues in the accompanying request: In segment 2, different work on cancer forecast utilizing AI methods are displayed. In segment 3, the proposed framework design and the point by point work process activities are discussed. In segment 4, the reproduction results have appeared. At last, in segment 5, conclusion and future work are displayed

2. Related work

2.1. Literatures which used fuzzy systems

Patricia Melin (2018) developed a crossbreed model utilizing evaluated neural structures and cushy system to give the hypertension risk confirmation of an individual.

This model mulls over age, chance portions and lead of the beat in a time of 24 h. A conscious neural system was composed, with three modules, of which the first and second modules diverge from the systolic and diastolic burdens and the last one to the beat. The learning exactness in the focal module is 98%, in the ensuing module is 97.62% and the third module is 97.83% autonomously. **Mehrbakhsh Nilashi (2017)** built up an information-based framework for chest threat guesses. They utilized assembling, uproar evacuation, and depiction methods for envisioning chest threatening development improvement. Their proposed learning-based framework shows to have pervasive want exactness (0.932) for chest ailment improvement when stood out from various techniques. **Vaishnav G. Kale (2018)** utilized a common data-based methodology for lung sickness assessment and finding. Minute lung pictures are taken for assessment and assessment by utilizing mechanized picture managing and MATLAB. The information parameters like entropy, standard deviation and MSE for customary data procedures are finished over a colossal little lung picture database. The individual quantifiable and numerical parameter assessment with its effect on lung peril pictures is enough done in end the exactness, selectivity, and affect the ability of the proposed strategy is directed by finishing the standard expressive.

2.2. Literatures which used neuro fuzzy systems

Atinc Yilmaz (2016) used the neuro-fuzzy model for lung threat conjecture. In their work, the risk of getting the lung malignant growth was resolved and a short time later status of the patient's weakness and assurance from stress is used in choosing the effects of stress to affliction. The accuracy of their system in danger figure of lung malignancy development was 94.64% as contrasted and Einstein item (93.18%) and ANFIS (92.04%). **Min Chen (2019)** built up a system for skin malady confirmation utilizing a restorative AI structure subject to information width improvement and self-learning. They utilized instructive aggregation channel estimation subject to data entropy to decrease the heaviness of edge focus and in the interim improve the learning furthest reaches of the remote cloud assessment model. It is discovered that the high-and low-destinations photographs of some skin afflictions have little effect on the depiction exactness. **Satarupa Banerjee (2016)** built up a feathery comprehension in an oral thriving and liking overview information for picked Indian individuals concerning surveying weakness to oral pre-ailment and hazardous advancement. The perspective also proposed the fragility to oral pre malignancies and squamous cell carcinoma in patients considering a feathery guideline base through If-Then measures with express conditions. Joining of closeness appraisals was utilized during change into the phonetic yield of the soft set to anticipate the ailment bring about a powerfully precise way and related state of the pertinent highlights.

2.3 Literatures which used RBFCM, TDABC and RHEUMA models

Aysegul Buyukavcu (2016) constructed a solid model that best in classes the conditions and consistent outcomes associations among the segments that are basic to general prosperity. They utilized a Rule- Based Fuzzy Cognitive Map (RBFCM) approach that successfully addresses learning and human experience, familiarizing thoughts with address the central segments and the conditions and consistent outcomes associations among the plans to show the direction of any structure. In their philosophy, a standard-based system was created to evaluate danger segments of bosom disease development reliant on the information from oncologists. A sensitive preparing procedure is used to emulate the movements of a system after some time and address the request to consider between different logical investigations. Chang-Yu Wang (2015) built up a hazard exhibiting and endurance figure structure dependent on a flexible neuro-fuzzy enlistment framework to help clinicians in the prognostic appraisal of patients with esophageal infection and in foreseeing the endurance of individual patients. Authentic qualities for serum C-responsive protein, albumins, and time interims were pledged to the model for use in anticipating the endurance of individual patients for various times. The bends gotten by the ANFIS approach were fitted to those picked up utilizing the true attributes. Bakhtiar Ostadi (2019) built up another component utilizing a fuzzy rationale for time driven-action based costing (TDABC) consolidated called an FL-TDABC framework. This framework is proposed for conditions of respectably accurate information that can unequivocally evaluate the cost of organizations given to patients. In this investigation, the fluffy framework in the TDABC model is used to decide the intrinsic uncleaness and helplessness and choose the best characteristics for cost, point of confinement, and time parameters to give definite information on the costs of the human administration's organizations. The FL-TDABC model uses seven key strides for cost assessment. Mohd Salim Qureshi (2018) consolidated fuzzy rationale control with sliding mode control for mechanical helped medical procedure, which is an innovative improvement in the restorative condition. Automated helped medical procedure (RAS) is a strategy for mechanical improvement in the remedial condition that uses mechanical structure to help cautious measures. RAS was planned to beat the containments of Minimal Invasive Surgery (MIS) and to improve the limit of a therapeutic expert during medicinal methodology. **Hamid Mahmoodian (2016)** built up a strategy for quality choice and fuzzy principle age for backsliding time forecast of bosom disease utilizing bolster vector relapse (SVR). This strategy uses the joined idea of relapse capacities and fluffy frameworks. According to the results, the score of association coefficients among envisioned and veritable break faith times of three instructive assortments has been improved to 0.718, 0.6481 and 0.5943 for 77, 19 and 37 models independently. **KP Adlassnig (1993)** utilized ADL4G-2/RHEUMA to distinguish the nearness of

rheumatic maladies in patients. CADIAG-2/RHEUMA is a helpful ace system made to help the differential analysis of rheumatic diseases. Considering the fuzzy set speculation and fuzzy method of reasoning, it supports the formalization of questionable and sketchy therapeutic change and arrives at real derivations from this free data. Given a patient's finding plan, CADIAG2 gives asserted and kept away from the breakdown, decisive theories, and suggestions for further evaluations.

3. The system architecture

The proposed structure relies upon the Mamdani derivation model of the fuzzy rationale framework for acknowledgment of basal cell carcinoma and squamous cell carcinoma. First, the outliers are removed from the data collected from the biopsy report of the patients. Then, the pure data is sent to the fuzzy system as an input. The next step is the construction of the membership function of the input data. Based on the membership function constructed, fuzzy if-then rules are generated in the fuzzy inference system. After defuzzification, the predicted output is generated by the fuzzy logic system. The system architecture for the above system is shown in figure 1

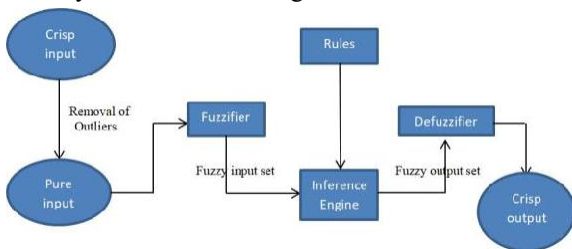


Fig. 1. The System Architecture

The fuzzy logic system composed of inputs and output is shown in Fig. 2

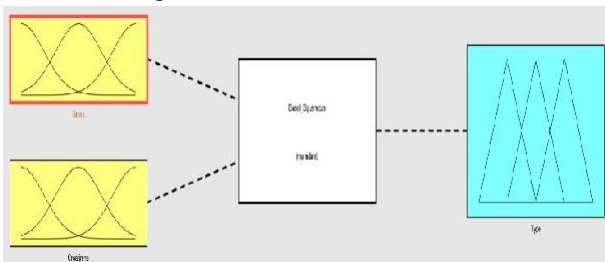


Fig. 2. The fuzzy logic system's inputs and output.

3.1. Input Gross

The scope of the three participation elements of Gross shown in Table 1

Table 1. Membership functions and ranges for Gross

Input – 1: Gross [0 – 20]		
Membership Function	Type	Range
Low	Trimf	[0 0.3 0.6]
Medium	Trimf	[0.5 0.75 1]
High	Trimf	[0.8 10.4 20]

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Creatinine

The scope of the three participation elements of Creatinine appears in Table 2

Table 2. Membership functions and ranges for Creatinine

Input – 2: Creatinine		
Membership Function	Type	Range
Low	Trimf	[-0.7 0 0.7]
Medium	Trimf	[0.6 1 1.4]
High	Trimf	[1.2 2.6 4]

3.2. Output Type

Type

The end result has two possibilities: BCC or SCC

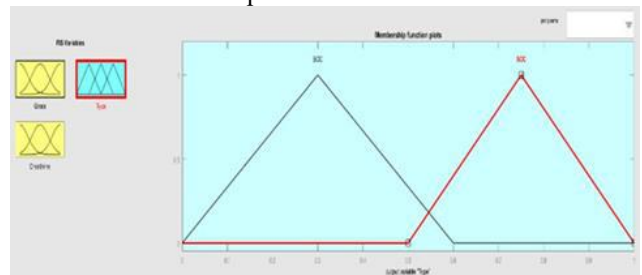


Fig. 3. Membership function plot for output Type

4. Results and Discussion

4.1 Datasets used

According to the biopsy report of the patients collected from the data source, there are two parameters involved namely: creatinine and gross to become the input for the fuzzy logic system. The normal input ranges along with their membership functions for these two datasets are shown in table 1 and 2. Simulation of the proposed system is done in MATLAB using the fuzzy designer toolkit. The input

creatinine is considered for removing the outliers. Removal of outliers is done with the help of a code written in MATLAB. After removal of outliers, the pure creatinine value is sent to the fuzzy logic system as an input. These pure values, in turn, are used for the construction of the membership functions. The equivalent code in MATLAB is written by following the steps of [12], to construct the membership functions. Table 3 shows the values obtained for the construction of new membership functions for input creatinine.

Table 3. Values obtained for the construction of membership functions of creatinine

Input – 1: creatinine: [0-4]		
Membership Function	Type	Range
Low	Trimf	[0.74 1.11 1.48]
Medium	Trimf	[1.46 2.29 3.11]
High	Trimf	[3.10 3.32 3.54]

Fig. 4 shows the newly constructed membership functions for creatinine

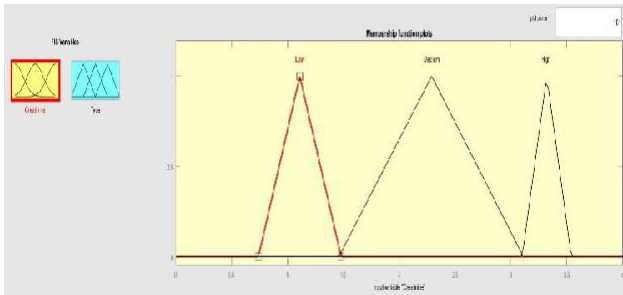


Fig. 4. Newly constructed MFs for creatinine

Based on the new membership function's values, the final rule base is designed according to which the system generates the predicted result which is compared with the actual result to obtain the accuracy level of the fuzzy system. Fig. 5 – Fig. 10 represents training and testing data with and without outliers along with their histograms

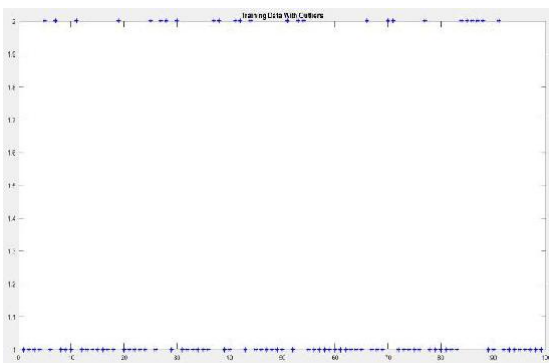


Fig. 5. Training data with outliers

Fig. 5 represents training data set before the removal of outliers. Out of 99 patient's data, the data of 70 patients are used for training the data set.

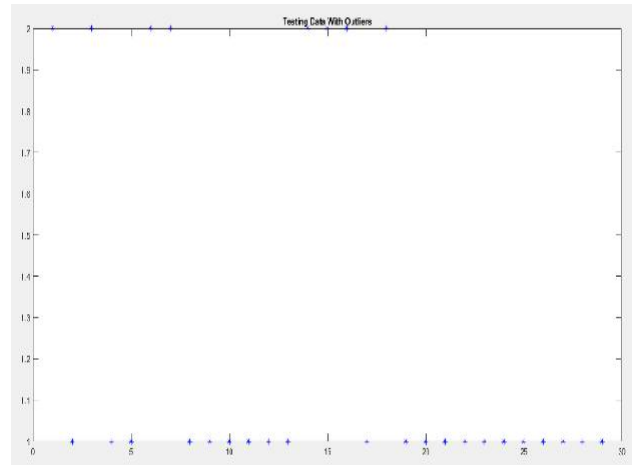


Fig. 6. Testing data with outliers

Fig. 6 represents the test data set before the removal of outliers. Remaining 27 patient's data out of 99 patient's data are used as the testing data set

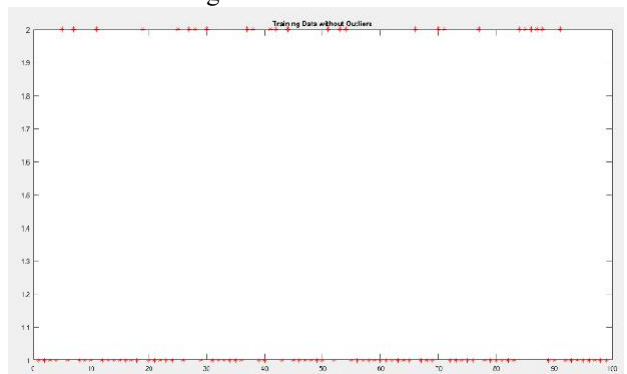


Fig. 7. Training data without outliers

Fig. 7 represents training data set after the removal of outliers. Outlier removal is performed on the creatinine input of the fuzzy logic system

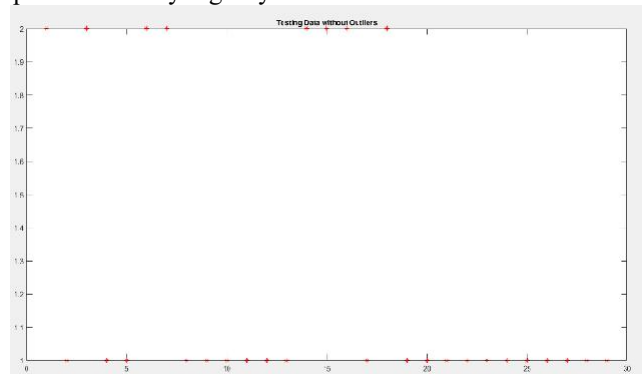


Fig. 8. Testing data without outliers

Fig. 8 represents test data set after the removal of outliers. 27 patient's data is used again as a test input for the given data set

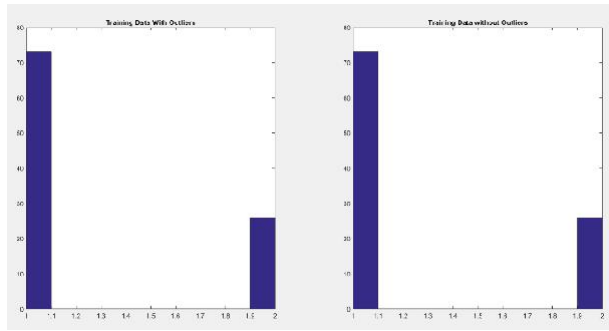


Fig. 9. Histogram of training data with and without outliers

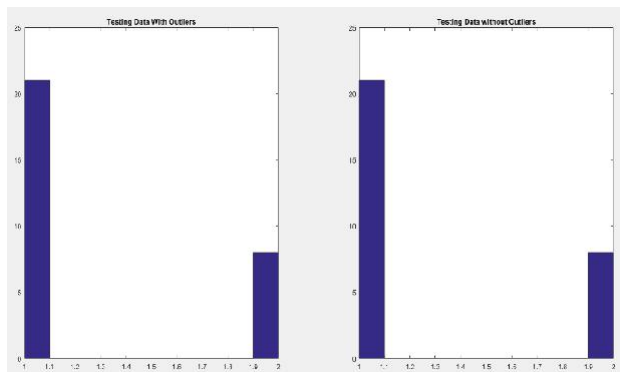


Fig. 10. Histogram of testing data with and without

Fig. 11 shows the comparison of predicted output Vs actual output. The total number of data elements is 99, out of which our system predicts correct results for 94 inputs, which gives an accuracy of 94.94%

	A	B	C	D	E	F	G	H	I	J	K	L
	CR	GR	TYPE	PREDICTED OUTPUT	MATCHING	ACTUAL OUTPUT						
1	1.64	0.3	1	0.3	✓	SCC						
2	0.9	0.4	2	0.4	✓	SCC						1. Basal cell carcinoma (BCC)
3	0.58	0.5	1	0.3	✓	BCC						2. Squamous cell carcinoma (SCC)
4	0.95	0.2	1	0.3	✓	BCC						
5	1.98	0.7	2	0.75	✓	SCC						
6	0.98	0.4	1	0.4	✓	BCC						
7	1.82	1	2	0.75	✓	SCC						
8	0.65	0.4	1	0.3	✓	BCC						
9	0.92	0.4	1	0.3	✓	BCC						
10	0.96	0.5	1	0.5	✓	BCC						
11	1.17	0.6	2	0.5	✗	BCC						
12	0.82	0.2	1	0.3	✓	BCC						
13	1.81	0.6	1	0.75	✗	SCC						
14	1.94	0.7	1	0.75	✗	BCC						
15	1.58	0.4	1	0.3	✓	BCC						
16	0.67	0.5	2	0.2	✓	BCC						
17	0.79	0.4	1	0.4	✓	BCC						
18	0.67	0.3	1	0.3	✓	BCC						
19	1.23	0.7	2	0.75	✓	SCC						
20	1.19	0.4	1	0.3	✓	BCC						
21	0.64	0.7	1	0.75	✗	SCC						
22	0.8	0.5	1	0.3	✓	BCC						
23	1.77	0.6	1	0.75	✗	SCC						
24	1.91	1.6	2	0.75	✓	SCC						
25	2.26	0.7	2	0.75	✓	SCC						
26	0.99	0.6	1	0.3	✓	BCC						
27	1.5	1	2	0.75	✓	SCC						
28	1.24	0.5	1	0.5	✓	BCC						
29	1.17	0.5	1	0.3	✓	BCC						

Fig. 11. Comparison of actual Vs. predicted output

5. Conclusion and future work

In this paper, a methodology to predict the existence of either basal cell carcinoma or squamous cell carcinoma among the given data of skin cancer diseases has been presented. Input data is first purified using the outlier removal technique, then the pure data becomes the input to the fuzzy logic system. The new membership value has been constructed and accordingly the rule base is designed, to generate the predicted output. Then, a comparison between the actual and the predicted output is done which gives an accuracy of 94.94%. The outcomes of the examination on the source dataset show

that the proposed system achieved extraordinary desire accuracy for the portrayal of squamous cell carcinoma and basal cell carcinoma. This paper introduces a new technique to predict the existence of multiple cancers (either basal cell or squamous cell) from the mixed cancer dataset. There is still a great deal of work to be done in making systems for squamous cell carcinoma and basal cell carcinoma contamination assurance using AI strategies to utilize every single point of convergence of these methods. Later on assessment, we expect to evaluate the proposed procedure with progressive learning on additional therapeutic educational lists and explicitly on gigantic instructive assortments.

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