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# Measurement Extraction using Fuzzy Set Rule for Segmented Features of Brain Tumor in T-1 & T-2 Weighted Images

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** For neuro radiologist it becomes hard to accumulate features with minute dissimilarity in plenty of cases, so it is hard to make a correct decision. Therefore, the need is to generate some rules for prediction of degree of malignancy in tumors.
**Design:** The pre-operative analysis of brain lesion is based on magnetic resonance imaging and clinical data set. Analysis of MRI finding and medical data set gives the relationship between regular pattern & interpretable pattern to acquire desired degree of malignancy. Until now the edge detection, segmentation and morphological operators are used to detect exact location of brain tumor. As uncertainty exits; here fuzzy set rules are evaluated to predict the degree by which a benign tumor is converted into malignant tumor.
**Methods:** Fuzzy extraction theory has been applied along with image progressing algorithms like edge detection; segmentation and morphological operation based on spectral transformation are used to detect exact location of brain tumor to predict the degree malignancy. Step of Image analysis: a) Preprocessing: input 2D gif or tiff image b) Filtering of image using Anisodiff filter c) Thresholding, applying morphological operators and tumor line detection.
**Statistical Analysis used:** A diagnostic feature includes blood flow, mass effect, temperature, calcification, edema, signal intensity & so on. Numerous features can be taken into consideration for better outcome.

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**Results:** Fuzzy set rule is one of the promising methods along with MR finding to achieve accuracy higher than 85% by considering few of the medical symptoms on different features.
**Conclusions:** This research is limited to specific region and type of glioma and thus cannot deal heterogeneous cases in which situation is much complicated. The result evaluated here are usually retroactive. As studied, by analyzing signal intensity of T-1 & T-2 weighted image alone, accuracy of 60-70% has been achieved. So in order to get higher accuracy feature like cyst generation, oedema, blood supply are included to achieve 85% accuracy.

*Keywords: Brain lesions; MRI; Fuzzy rule; classification.*

## 1. INTRODUCTION

The increase of extra cells normally forms an enlarged tissue called a tumor. The survival rate greatly depends upon the grade of glioma, also the treatment for the brain tumor greatly depends on the degree of malignancy. There are three common types of tumor: 1) Benign; 2) Pre-Malignant; 3) Malignant (cancer can only be malignant) [1]. For neuro radiologist it becomes hard to accumulate features with minute dissimilarity in plenty of cases, so it is hard to make a correct decision. If this error happens in detection of glioma degree i.e. low grade will be detected as high grade, misfortune occurs. Inorder to deal with such situation, it is required that large clinical data set and MRI findings have been studied to evaluate difference between regular and interpretable shapes.

To attain this some restrictions are taken into consideration:

1) Precision: the precision to be considered for regular pattern must be above 80%.
2) Shape strength: shapes like round, ellipse and irregular were diagnosed by different neuro radiologist as similar shape. This kind of uncertainty is most common, so precise evaluation is not possible. Any regular pattern recognized must be as robust as possible to this sort of uncertainty.
3) Understand clear difference between regular and irregular by neuro radiologist.

A large number of machine learning algorithm like fuzzy C-means (FCM), linear-regression, K-nearest neighbor (KNN), support vector machine (SVM), random forest and soon have been built up and used for the detection of brain tumor [2]. Deep learning approaches will play a significant role in medical image segmentation [3]. Existence of masses of tools aims to do beneficial research but it is hardly beneficial for clinicians. Research is always worked to get higher outcomes, however still there exists need for enhancement in transformation techniques, for precisely detecting the location of brain tumor [4,5].To predict degree of malignancy in brain tumor [6] is necessary for treatment decision, if the grade is I or II, the success rate of treatment is higher; if not, there exists high risk during surgery, which results in poor life quality [7]. At the present, for pre operative analysis, Magnetic Resonance Imaging (MRI) findings [8] and medical data set [1] are required before operations. Some features obtained during analysis are unrelated and even not needed, but these make the prediction of the degree of malignancy a hard task. For neuro radiologist it becomes hard to accumulate features with minute dissimilarity in plenty of cases, so it is hard to make a correct decision. Therefore, the need is to generate some rules for prediction of degree of malignancy in tumors. Artificial neural networks (ANNs) are dominant in medical imaging, and have been used extensively [9]. In this paper author explained the C4.5 Rule-PANE method, which has high accuracy and is easy to understand [10]. Author proposed a fuzzy rule extraction algorithm based on fuzzy min-max neural networks (FMMNN-FRE), even though the rules are easy to understand, the accuracy of FMMNN-FRE was less than ANNs [11].

Three different ways for tumor analysis algorithms are -techniques are pixel based, texture based or some of them based on structure of images. Author suggested an improved technique for tumor detection; this algorithm used neuro fuzzy technique for the segmentation for the tumor detection [12]. A new approach is proposed which uses a clustering technique (k-means) to detect the brain tumor in MR images [13]. Author proposed a technique to detect tumors from MR images using fuzzy clustering technique. The drawback of this technique is the computational time required [14]. Generalized fuzzy operator (GFO) is a new approach which is proposed to detect contour of

brain tumor. One typical example is used for evaluating this method with the contour deformable model [15]. Mostly four steps are used, Pre-processing & region localization, Segmentation & edge detection, Feature extraction and evaluation of outcome for accuracy. [16]. this technique is based on a modified fuzzy c-means clustering algorithm [17, 18, 19, 20] for clustering of membership function it uses spatial information.

## 2. METHODS

The below listed parameters can be considered during fuzzy algorithm to differentiate tumor cell and normal cell inorder to detect degree of malignancy. Here, a novel fuzzy image approach is proposed for detection of degree of malignancy.

A combination of algorithm using fuzzy logic to detect tumor in premature stage is proposed. Step involved for the result and necessary tool used for the outcome is given below:

a. Image pre-processing and filtering using anisotropic diffusion.
b. Image segmentation using morphological operators. Thresholding, applying morphological operators and tumor line detection.
c. Fuzzification & Defuzzification using fuzzy set rules using fuzzy reasoning.
d. Edge detection using canny edge detector.

Fuzzy set rule is one of the promising methods along with MR finding to achieve accuracy higher than 85% by considering few of the medical symptoms on different features. Image representation in matrix form has been utilized in fuzzy set for defining membership function [21, 22].

Rule 1: Age, Gender, Blood flow (normal ,a bit normal) AND tumor with hypo intense weight on T1 image(light) AND hemorrhage(acute) AND Capsule of tumor( absent) THEN low grade(grade I & II).

Rule 2: Age, Gender, Blood flow (abnormal) AND tumor with hyper intense weight on T1 image (middle, heavy) AND hemorrhage (chronic) AND Capsule of tumor (present) THEN high grade (grade III & IV).

For example: if a 25 year male MR finding denotes shape: irregular, Blood flow: a bit normal, edema: light, hemorrhage: acute, Capsule of tumor: absent then finding outcome will be low grade

Mathematical representation of fuzzy rule will be:

$\min_{\text{rule 1}}(\text{case}) = \min\{(\max_{\text{Vage}}\mu(25), \max_{\text{Vblood flow}} \mu(\text{a bit normal}), \max_{\text{Vedema}} \mu(\text{light}), \max_{\text{V hemorrhage}} \mu(\text{acute}),$

$\max_{\text{VCapsule of tumour}}\mu(\text{absent})\}$

$\min_{\text{rule 1}}(\text{case}) = \min(0, 1, 1, 0)$

**Table 1. Characteristics of normal & cancerous cell**

| S. no | Parameter of difference | Normal cell | Cancerous Cell |
|---|---|---|---|
| 1. | Shape | Regular shape & size | Irregular shape & size |
| 2. | Temperature | normal | high |
| 3. | Blood Flow | normal | increases |
| 4. | Production of Protein | Normal production | Enhanced production |
| 5. | Golgi Apparatus | developed | Poorly developed |
| 6. | Peroxisomes | absent | present |
| 7. | Enzyme content | normal | reduced |

*Some of the parameters which differentiate normal and cancerous cells are listed in the table*

The proposed algorithm rule can be given as-

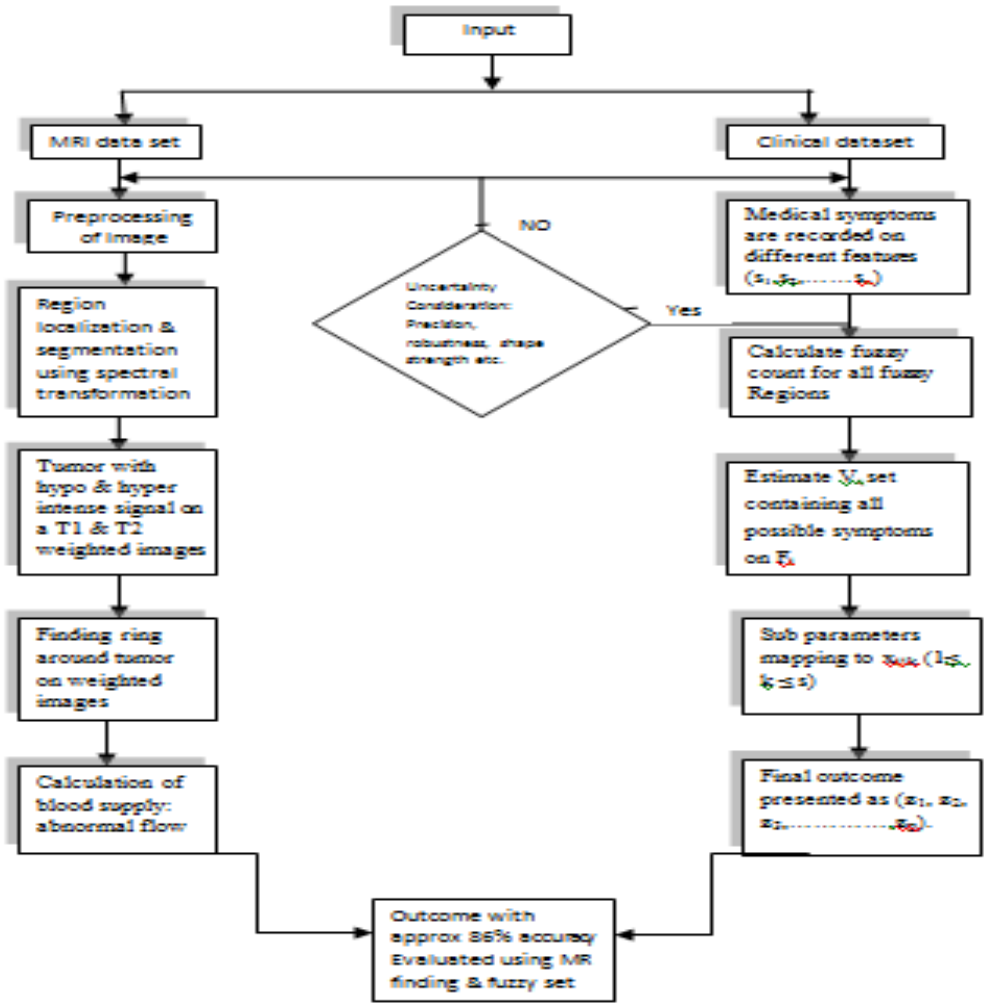


**Fig. 1. Algorithm for fuzzy image processing**

The pre-operative analysis of brain lesion is based on magnetic resonance imaging and clinical data set. Analysis of MRI finding and medical data set gives the relationship between regular pattern & interpretable pattern to acquire desired degree of malignancy [23,24]. As uncertainty exits fuzzy extraction theory has been applied along with image progressing algorithms like edge detection, segmentation and morphological operation based on spectral transformation are used to detect exact location of brain tumor to predict the degree malignancy.

## 3. RESULTS

To obtain noiseless, smooth and enhanced region of interest, post processing of MR images is necessary.

The first step to analyze the image is Preprocessing i.e. Preprocessing & post processing of image- Resizing, filtering, eroding.

Fig. 2 represents the image data base. Images considered here are either in gif or tiff format, as the filter used in this study i.e. anisodiff which works on giff/tiff format. Fig. 3 is the representation of coding in Matlab 2014(a) version.

The next step is to enhance the image and find region of interest.

Fig. 5 shows the input scaled image with intensity plot and preprocessing as resized image.

Fig. 6 represent Preprocessing & post processing of image, for image preprocessing Hough transform is used. After image analysis tumor outline is obtained.

## 4. DISCUSSION

The approach discussed in this paper presents a combination of fuzzy set rule theory with image processing algorithm. In this paper some parameters have been considered to differentiate normal & abnormal cell. By considering seven parameters, accuracy of 85% has been achieved. Inorder to increase the efficacy more parameters with large data set should be considered.

The pre-operative analysis of brain lesion is based on magnetic resonance imaging and clinical data set. Analysis of MRI finding and medical data set gives the relationship between regular pattern & interpretable pattern to acquire desired degree of malignancy. As uncertainty exits fuzzy extraction theory has been applied along with image progressing algorithms. Though, it must be noted that in this research, many limitations exist. Noticeably, this is a retrospective propose research, in addition, large data set can be considered. In future, the research can further relate the important molecular mechanisms of independent features of survival, large scale dataset must be considered for prospective studies.


**Fig. 2. Image data set**

```
clc;

warning off;

addpath('subfn\');

% ======== Getting Input Image ========== %

[file,path] = uigetfile('*.*'); % Get gif images from dataset


if file ~= 0

    tic

    I = imread([path file]); % Read input image

    I = imresize(I,[256 256]);

    im = im2double(I);

    figure('Name','Input Image')
```

**Fig. 3. Matlab code for image analysis**

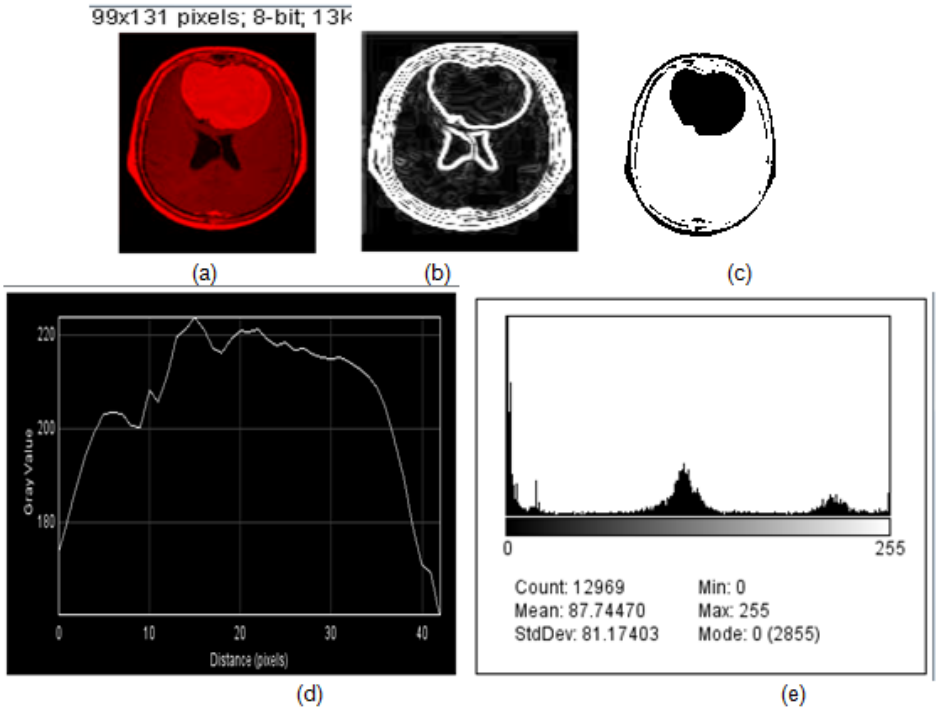


**Fig. 4. a) Invert LUT & highlighting the region of interest, b) edge detection, c) threshold image, d) plot profile if ROI, e) histogram equalization**

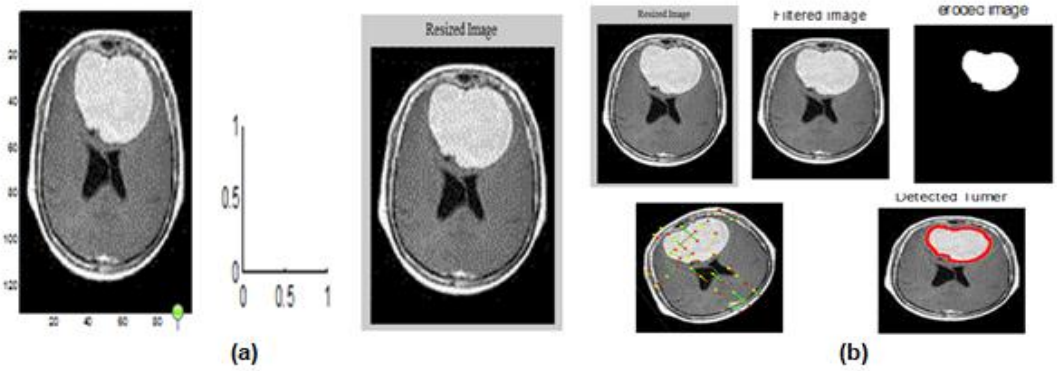


**Fig. 5. (a) Input scaled image; (b) Resized image**

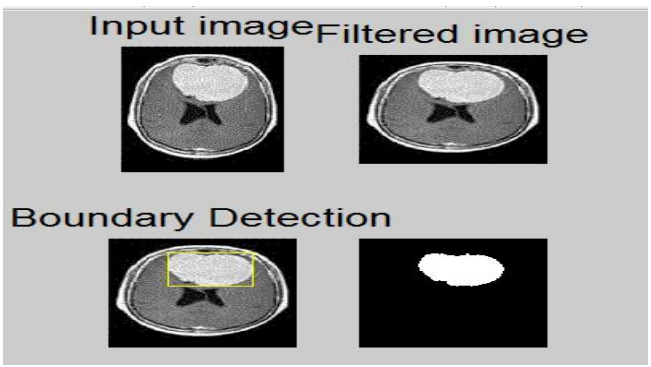


**Fig. 6. Outcome of fuzzy image processing algorithm**

Future researches are going on in the direction of image processing (edge and segmentation of medical images) which will lead towards improving the accuracy, exactness, and computational speed, as well as minimizing the amount of manual interaction. These approaches can be enhanced by incorporate discrete and continuous-based segmentation methods. In future it will help doctors in tumor monitoring.

## 5. CONCLUSION

This research is limited to specific region and type of glioma and thus cannot deal heterogeneous cases in which situation is much complicated. The result evaluated here are usually retroactive. As studied, by analyzing signal intensity of T-1 & T-2 weighted image alone, accuracy of 60-70% has been achieved. So in order to get higher accuracy feature like cyst generation, oedema, blood supply are included to achieve 85% accuracy.

With the proposed algorithm, investigation performed for 253 brain glioma images dataset. According to the outcome, the features that are more useful; they were age, cyst generation, oedema, blood supply, mass effect, calcification & T1 weighted image signal intensity. Mostly the first three was present in 150 cases as studied from 253 but the rest occurs independently. Capsule of tumor, also present in most of the cases.

The image dataset has total of 253 images

For the above dataset

$$\text{Accuracy} = \frac{(TP + TN)}{(FP + TN) + (TP + TN)}$$

$$\text{Acc} = \frac{143 + 92}{98 + 149} = 95\%$$

The accuracy of the proposed algorithm was 95%, it was very near to that of the MLP 96.1%, & nearest neighbor 96.2%, average accuracy was higher than that of the ID3 94.4% & the FMMNN 86.5%. The understandability, of the proposed algorithm was comparable with the discussed algorithms.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES


1. Khanaa DKMV. An Efficient Contrast Enhancement of Medical X-Ray Images - Adaptive Region Growing Approach. Int. jour. eng. com. Sci. 2013;2(02).
2. DimpeeChandarana, Ashish M. Kothari ,"Brain Tumor Segmentation Methods: A Review. International Journal of Advance Engineering and Research Development (IJAERD);2015.
3. Mehena J, Adhikary MC. Brain Tumor Segmentation and Extraction of MR Images Based on Improved Watershed Transform. IOSR Journal; 2015.
4. Jin Liu, Min Li, Jianxin Wang et al. A survey of MRI-based brain tumor segmentation methods. Tsinghua Science and Technology;2014.
5. Benjamin M. Ellingson, Martin Bendszus, A. Gregory Sorensen, Whitney B. Pope, Emerging techniques and technologies in brain tumor imaging, Neuro-Oncology;2014
6. Rai HM, Chatterjee K. Detection of brain abnormality by a novel Lu-Net deep neural CNN model from MR images. Machine Learning with Applications. 2020;2.
7. Hesamian MH, Jia W, He X, et al. Deep learning techniques for medical image segmentation: achievements and challenges. J Digit Imaging. 2019;32:582–596.
   Available: https://doi.org/10.1007/s10278-019-00227
8. Huang RY, Dung LR, Chu CF, Wu YY. Noise Removal and Contrast Enhancement for X-Ray Images. JBEMI. 2016;3(1):56.
9. Bredel M, Pollack IF. The p21-Ras signal transduction pathway and growth regulation in human high-grade gliomas. Brain Res Brain Res Rev;1999.
   DOI: 10.1016/s0165-0173(98)00057-5.
10. Wang C, Zhang J, Liu A, Sun B, Zhao Y. Surgical treatment of primary midbrain gliomas. Surg Neurol;2000.
    DOI: 10.1016/s0090-3019(99)00165-2.
11. Lopez-Gonzalez MA, Sotelo J. Brain tumors in Mexico: characteristics and prognosis of glioblastoma. Surg Neurol;2000.

DOI: 10.1016/s0090-3019(99)00177-9.
12. Zhi-Hua Zhou, Yuan Jiang. Medical diagnosis with C4.5 rule preceded by artificial neural network ensemble. In IEEE Transactions on Information Technology in Biomedicine. 2003;7(1):37-42. DOI: 10.1109/TITB.2003.808498..
13. Ye CZ, Yang J, Geng DY, et al. Fuzzy rules to predict degree of malignancy in brain glioma. Med Bio Eng Comput. 2002;40:145–152. Available:https://doi.org/10.1007/BF02348118
14. Oelze ML, Zachary JF, O'Brien WD, Jr. Differentiation of tumor types in vivo by scatterer property estimates and parametric images using ultrasound backscatter. 2003;1(5-8):1014 – 1017.
15. Joshi, Dipali M. et al. “Classification of Brain Cancer using Artificial Neural Network. International Conference on Electronic Computer Technology. 2010;112-116.
16. Ming niwu, chia-chen Lin, chin-chenchang. Brain Tumor Detection Using Color-Based K-Means Clustering Segmentation. Intelligent Information Hiding and Multimedia Signal Processing;2007.
17. Hossam M. Moftah, Aboul Ella Hassanien, MohamoudShoman. 3D Brain Tumor Segmentation Scheme using K-mean Clustering and Connected Component Labeling Algorithms. Intelligent Systems Design and Applications (ISDA);2010.
18. Gopal NN, Karnan M. Diagnose brain tumor through MRI using image processing clustering algorithms such as Fuzzy C Means along with intelligent optimization techniques. Computational Intelligence and Computing Research (ICCIC), IEEE International Conference;2010.
19. Vasuda P, Satheesh S. Improved Fuzzy C-Means Algorithm for MR Brain Image Segmentation. (IJCSE) International Journal on Computer Science and Engineering. 2010(02):05.
20. Kannan SR. Segmentation of MRI Using New Unsupervised Fuzzy C Mean Algorithm”. ICGST-GVIP Journal. 2005;5(2).
21. Leung CC, Chen WF, Kwok PCK, Chan FHY. Brain tumor boundary detection in MR image with generalized fuzzy operator” *ICIP* 2003. Proceedings. International Conference on. 2003;2:14-17.
22. Zarandi MHF, et al. Using Type-2 fuzzy function for diagnosing brain tumors based on image processing approach” *Fuzzy Systems* (FUZZ), 2010 IEEE International Conference on;2010.
23. Chow KL et al, “Prognostic factors in recurrent glioblastomamultiformeandanaplastic astrocytoma, treated with selective intra-arteral chemotherapy. AJNR Am J Neuroradiol. 2000;21:471–478.
24. Paulo JG, Lisboa ECI, Piotr SS (Eds.). Artificial Neural Networks in Biomedicine. Springer-Verlag, London;2000.



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