# Development and Porting Of Mathematical Model to Design a PixTra Algorithm for Detection of Brain Tumor

**Rahul Khalate, Vineeta Basotia, Dilip.B.Ghule**

***Abstract:*** ***The goal of applied mathematics is to develop and implement the automated systems, services and support to execute engineering goals. Game theory is always a domain of choice for development of strategy to enhance the usability of mathematical applications. Today, there is rarely any system which works without keeping mathematics behind the curtain. A recent trend in medical imaging leads via mathematical algorithmic development for brain tumor analysis. The deep learning technology is a mathematical strategic solution to identify the brain tumor from medical resonance imaging. The game theory strategic development is necessary for mathematical modeling of image technologies as pixel level calculations are required. Hence, this paper shows the newly developed mathematical modeling for efficient brain tumor detection using game theory and set theory. This paper also suggests the new algorithm which is ported from mathematical modeling for deep learning brain tumor image processing.***

***Index Terms:*** ***Game Theory, Mathematical modeling, set theory, integral application, Markova Analysis, image processing, algorithm modeling***

## I. INTRODUCTION

Statistics powered computational neurological tumor systems possess the possibilities to offer trial and error tumor surgeon by way of this kind of quantitative and as well , economical applications to create and check hypotheses on cancerous growth development, and to provide primary functioning guidelines regulating bidirectional transmission diffusion in multi-cellular malignancy models [1, 2, 3, 4].An enhanced recognizing of the untouched difficulty of these types of malignancy models needs reinforced interdisciplinary exploration in which usually the subsequent technology of progressive computational designs, knowledgeable by means of and then continually modified with experimental statistics, will certainly perform an essential part of leading trial and error model and pattern in heading ahead. Various interesting and as well, crucial complications in scientific research and technological know-how provoke to inverse conditions; that is certainly to identify an unfamiliar action or to approximate variables out of over-specified information and facts [5, 6]. The solutions include a multitude of undeniable positive aspects, which in turn consist of the mathematical models, the likeness of the strategies for challenges with linear and nonlinear players of game theory [7], the substantial accuracy of alternatives [8].

Neurological tumors cell layers [9, 10, 11] are extensively noted to be extremely diffusive and penetrating in comparison with the various other sort of cancer. The tumor aggregate has simply no clear perimeters and it covers up region inside the cranial cavity [12]. Plenty of analysts analyzed heterogeneous malignancy cell relationships through the growth mass by using many game theoretic [13] strategies which includes traditional ordinary type games, replicator characteristics, as well as, spatial games.

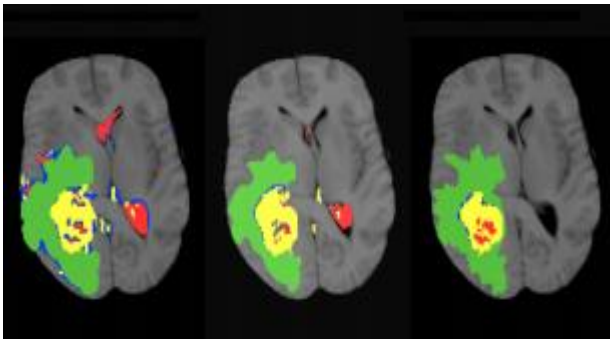

**Figure 1- Representation of Cancerous Brain tumor [14]**

A significant development in latest game theory has become the crucial for spatial framework together with classic games. Existing research have got investigated the evolution and management of co-operation in the prisoner's problem and also various other types [14]. Spatial games are actually especially important to the research of malignancy development as cell duplication and useful resource rivals is localized at the time of cancerous growth [15, 16]. For proposed research we formulated the classification as well as, investigation of statistics with game theory pixel rendering and set theory. Set theory with attribute elimination algorithm is employed for sorting the enhanced and necrotic cells.

The proposed mathematical model and ported PixTra algorithm is targeted for post-surgical analysis tool which can be used as a second opinion with accuracy for brain tumor patient.

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## II. PROPOSED METHODOLOGY

The core aim of proposed methodology is to develop mathematical model for identification of brain tumor with analysis of medical resonance image (MRI). The game theory is used for decision development for pixel rendering. Also, the set theory is used to make cluster of gray and white pixel sets. The ultimate aim of proposed research is the identification of specific tumor pixels. The proposed methodology is comprised of two stages: first is to travel till gray pixel with game theory player pixels and second is to develop the set of gray and white pixels. The benefit of using game theory approach is to travel each and every pixel for iterative identification of tumor boundary pixels as shown in figure 2 (a, b, c) below. The mathematical model is as discussed further.

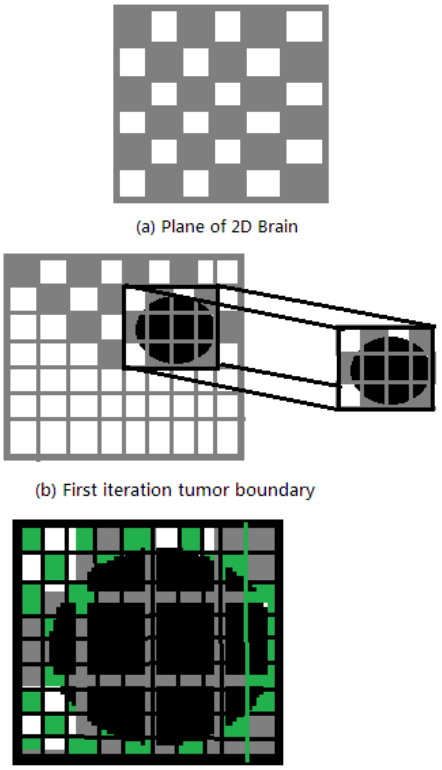


**Figure 2(a, b, c) –Iterative Tumor Boundary Extraction (Self contribution)**

In medical imaging, 2D brain image is represented by (p, q) 7→ f (p, q). The value of image function 'f' with coordinates (p, q) is positive and can be calculated by input brain MRI. In terms of clear visibility, values are proportional to gray and white pixels. Hence, f (p, q) must not be zero and infinite. So, condition must satisfy as:

$$0 < f(p, q) < \infty \quad (1)$$

Further, 'f' considers the 2D image intensity one for white pixel as m(p, q) and for gray pixel as n(p, q) and hence,

$$f(p, q) = m(p, q)r(p, q) \quad (2)$$

where , $0 < m(p, q) < \infty$ and $0 < n(p, q) < 1$

This is applicable to brain MR images pixel segregation. Now, with overall pixel limit we get,

$$P_{min} \leq l = f(p, q) \leq P_{max} \quad (3)$$

Since, l = f(p, q) is the pixel with coordinates (p, q). The pixel coordinates will shift within [Pmin, Pmax] with the time interval [0, T − 1]. Where, 'T' is maximum time interval. Then l = 0 is gray pixel and l = T − 1 is white pixel as per game theory player consideration. The proposed flow of modeling is shown in figure 2 below with consideration of application of brain tumor detection using deep learning mathematical modeling.

Apart from mathematical model developed, figure 3 shows the sequence of functions executed during the porting (translating) mathematical model in to new PixTra algorithm development. The name of ported algorithm is "PixTra" i.e. pixel traversing to identify the gray pixel boundary. The porting of mathematical model is always necessary when application is developed for end user.

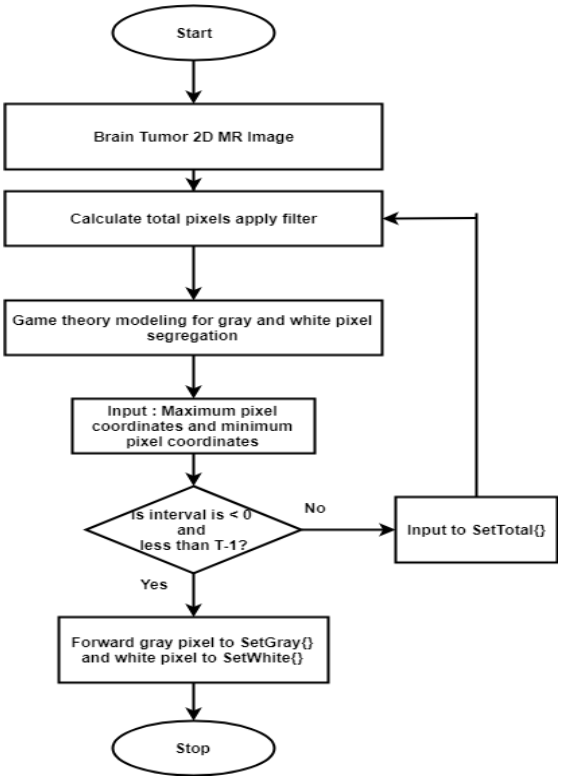


**Figure 3–Proposed PixTra Modeling**

The flowchart shows the input two dimensional (2D) brain images with assumption that brain MR image has affected area by tumor growth. The game player is considered as two coordinates of pixel at position (0,0) and travel with zigzag line to identify first gray pixel coordinates. Once the first gray pixel coordinates are found, the game player shifts there base coordinate to newly found gray pixel coordinate and second set starts with coordinate (0,0) to travel through only white pixels. The intensity of pixel is a key to travel and identify the gray and white pixel coordinates.

Further, the set of gray pixel coordinates are stored as a cluster of pixels to declare the boundary of tumor. To validate the total area of brain and set of gray pixels and white pixels, validation is carried out.

The mathematical algorithm is ported to PixTra algorithm and executes at application level as shown in following algorithmic steps:

**Proposed Algorithm: PixTra**

1. Input: 2D brain MR images
2. Get total number of pixels for 2D brain image

3. Apply game theory model for pixel rendering
4. Apply pixel segregation
5. Extract gray pixels coordinates and save to Set1
6. Extract white pixels coordinates and save to Set1
7. Find maximum and minimum pixel coordinates for whole image
8. Find maximum and minimum pixel coordinates for tumor
9. If tumor pixel coordinate/area > whole image pixels
10. Go to step- 2
11. Else
12. Show final pixel set for gray pixel area
13. Show final pixel set for white pixel area
14. If addition of gray area and white area equals the whole brain pixel area
15. End
14. Else
15. Show exception message
16. Go to step-1

For proposed research, we used BRATS2018 brain MRI dataset. The mathematical model is used as a ported algorithm with deep learning approach using Tensorflow and Keras. To test the efficiency and accuracy of applied mathematical application we run the test on gpu.

The testing of proposed model is done for 100 MRI data and results are discussed in next section of this paper.

## III. Result Analysis

The expectation of results is all about getting minimum percentage error for mapping the success of game theory player pixels. The following table-1 shows the percentage pixel sets for gray and white pixels. The total matching pixels need to be 100% so that the accuracy said to be excellent. The percentage error is considered either as a bad image modeling or missing iteration while traversing through pixel coordinates.

**Table 1- Pixel Set Accuracy**

| Enhanced and Necrotic Tumor MRI | Set-Gray Pixel (%) | Set-White Pixel (%) | Total Matching Pixel (%) | Error (%) |
|---|---|---|---|---|
| | 15 | 80 | 95 | 5 |
| | 18 | 82 | 100 | 0 |
| | 21 | 79 | 100 | 0 |

Further to that, PixTra mathematical model analysis as in table-2 shows the results for input of 10, 50 and 100 brain tumor images.

**Table 2- PixTra Mathematical Model TestingResults**

| Number of MR images | Tumor Accuracy (%) | Efficiency (%) |
|---|---|---|
| | | |
| 10 | 91.899 | 76.372 |
| 50 | 91.816 | 85.956 |
| 100 | 92.002 | 92.312 |

The analysis proves that the PixTra can identify tumor accuracy approximately 91% with application efficiency of maximum of 92.312% for 100 input images. This depicts that, while testing mathematical model using deep learning, as number of input images are more, the more efficient results we get.

## IV. Conclusion

As mathematics is a backbone of numerous engineering applications, the proposed research proved the development of mathematical model for brain tumor MRI followed by porting of mathematical model in to PixTra algorithm. The execution of model using game theory and set theory is the best option to render brain tumor pixels very fast. The game theory strategic management for pixel position is the key area of significance in mathematical modeling. Hence, efficiency and accuracy is more. This application of mathematics is very useful for automatic brain tumor classification and identification of exact boundary of tumor. As a post operative session, doctors can use this application to avoid recurrent surgery of patient's brain. Also, robotics guided surgical events can be successfully executed with proposed research as a baseline for future development.

## References

1. Barrera, D., et al. "Isotropic versus anisotropic techniques in cardiac computed tomography images processing." Journal of Physics: Conference Series. Vol. 1160. No. 1. IOP Publishing, 2019.
2. Smith, Frank T., Hemen Dutta, and John N. Mordeson, eds. Mathematics Applied to Engineering, Modelling, and Social Issues. Vol. 200. Springer, 2019.
3. Ram, Mangey. "Mathematics in Engineering Sciences: Novel Theories, Technologies, and Applications." (2019).
4. Ghani, Rizwan, et al. "Comprehensive evaluation of h-index and its extensions in the domain of mathematics." Scientometrics 118.3 (2019): 809-822.
5. Keener, James P. Principles of applied mathematics: transformation and approximation. CRC Press, 2018.
6. Pitman, Edwin JG. Some Basic Theory for Statistical Inference: Monographs on Applied Probability and Statistics. Chapman and Hall/CRC, 2018.
7. Higham, Catherine F., and Desmond J. Higham. "Deep learning: An introduction for applied mathematicians." arXiv preprint arXiv:1801.05894 (2018).
8. Maaß, Jürgen, et al. "Teaching Real World Mathematics: Some Background Theory." Mathematical Modelling for Teachers. Springer, Cham, 2018. 149-159.
9. Lokeshgupta, Bhamidi, and Shanmugavelu Sivasubramani. "Cooperative game theory approach for multi-objective home energy management with renewable energy integration." IET Smart Grid 2.1 (2019): 34-41.
10. Staňková, Kateřina, et al. "Optimizing cancer treatment using game theory: A review." JAMA oncology 5.1 (2019): 96-103.
11. Khalil, Ahmed Mostafa, et al. "More on "n-valued refined neutrosophic soft set theory"." Journal of Intelligent & Fuzzy Systems Preprint (2019): 1-7.
12. Hafezalkotob, Arian, et al. "An overview of MULTIMOORA for multi-criteria decision-making: Theory, developments, applications, and challenges." Information Fusion 51 (2019): 145-177.
13. Perrillat-Mercerot, Angélique, et al. "Mathematical Modeling of Substrates Fluxes and Tumor Growth in the Brain." Acta biotheoretica 67.2 (2019): 149-175.
14. Hussain, Saddam, Syed Muhammad Anwar, and Muhammad Majid. "Segmentation of glioma tumors in brain using deep convolutional neural network." Neurocomputing 282 (2018): 248-261.
15. Winter, Felix, Catrin Bludszuweit-Philipp, and Olaf Wolkenhauer. "Mathematical analysis of the influence of brain metabolism on the BOLD signal in Alzheimer's disease." Journal of Cerebral Blood Flow & Metabolism 38.2 (2018): 304-316.
16. Veronese, Mattia, et al. "Covariance statistics and network analysis of brain PET imaging studies." Scientific reports 9.1 (2019): 2496.