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CLASSIFICATION OF MAGNETIC RESONANCE IMAGES USING K-NEIGHBOUR ALGORITHM

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Abstract

An MRI test uses magnets and radio waves to capture images inside your body without making a surgical incision. It can be performed on any part of your body. A knee MRI looks specifically at your knee and its surrounding areas. An MRI lets your doctor see the soft tissues in your body along with the bones. This allows them to inspect the elements of the knee that might have been injured during physical activity or from wear and tear. The test can also provide detailed images of various sections of the knee, such as bones, cartilage, tendons, muscles, blood vessels, and ligaments. An MRI takes images in better contrast than other tests. Your doctor may want you to undergo a special kind of MRI called an MRI arteriogram. For this procedure, your doctor will inject a contrast fluid, or dye, into your knee to provide a better view of its structure.

The k-nearest neighbors (KNN) algorithm is a simple, supervised machine learning algorithm that can be used to solve both classification and regression problems. It's easy to implement and understand, but has a major drawback of becoming significantly slower as the size of that data in use grows.

Keywords: Magnetic Resonance Imaging, K-Nearest Algorithm.

INTRODUCTION

Early detection and classification of knee issues are very important in clinical practice. Numerous analysts have proposed outstanding methods for the identification of the type of issues based on different sources of facts. The knee pain is an uncontrolled boom in unsuitable human lifestyles and residing and unbalanced diet. According to the World Health Organization, tumors can be labeled into subsequent organizations.

Grade I: ACL injury**,** ACL injury is particularly common in people who play basketball, soccer or other sports that require sudden changes in direction.

Grade II: Fractures, People whose bones have been weakened by osteoporosis can sometimes sustain a knee fracture simply by stepping wrong.

Grade III: Torn meniscus**,** it can be torn if you suddenly twist your knee while bearing weight on it.

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Grade IV: Knee bursitis**,** some knee injuries cause inflammation in the bursae, the small sacs of fluid that cushion the outside of your knee joint so that tendons and ligaments glide smoothly over the joint

Grade V: Patellar tendinitis, Runners, skiers, cyclists, and those involved in jumping sports and activities may develop inflammation in the patellar tendon, which connects the quadriceps muscle on the front of the thigh to the

shinbone. Many diagnostic imaging methods, including Computed Tomography (CT), Positron Emission Tomography (PET), and Magnetic Resonance Imaging (MRI) may be used for early diagnosis of knee problems. MRI is green in the utility of diagnosis and identification relative to other imaging approaches due to high soft tissue assessment, high spatial judgment and it does not emit any harmful radiation and is a non-invasive solution. There are 4 main steps in the method for knee issues, classification as shown in Figure 1.

This invasive technique-related weakness calls for the implementation of new assessment approaches aimed at increasing the diagnostic capacity of MR images. This paper focuses on the study of Magnetic Resonance (MR) pictures and Magnetic Resonance Spectroscopy (MRS)

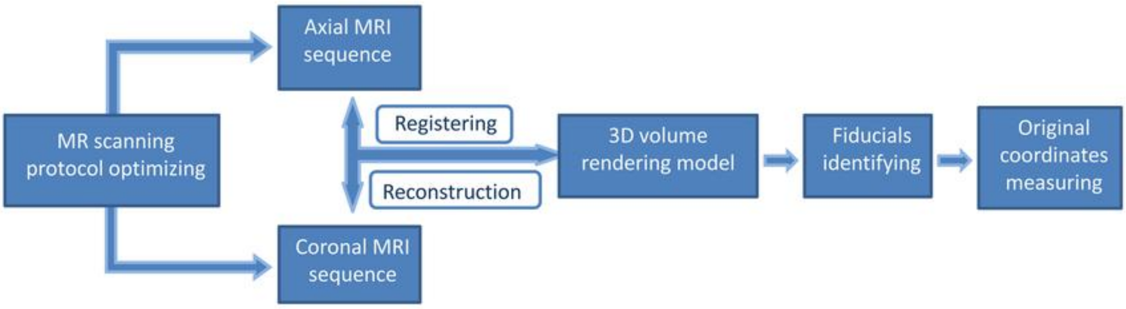

Figure 1. MRI SCANNING PROTOCOLS

Figure.2 MRI SCAN IMAGE

Types of arthritis

More than 100 different types of arthritis exist. The varieties most likely to affect the knee include:

- **Osteoarthritis.** Sometimes called degenerative arthritis, osteoarthritis is the most common type of arthritis. It's a wear-and-tear condition that occurs when the cartilage in your knee deteriorates with use and age.
- **Rheumatoid arthritis.** The most debilitating form of arthritis, rheumatoid arthritis is an autoimmune condition that can affect almost any joint in your body, including your knees. Although rheumatoid arthritis is a chronic disease, it tends to vary in severity and may even come and go.
- **Gout.** This type of arthritis occurs when uric acid crystals build up in the joint. While gout most commonly affects the big toe, it can also occur in the knee.

- **Pseudo gout.** Often mistaken for gout, pseudo gout is caused by calcium-containing crystals that develop in the joint fluid. Knees are the most common joint affected by pseudo gout.
- **Septic arthritis.** Sometimes your knee joint can become infected, leading to swelling, pain and redness. Septic arthritis often occurs with a fever, and there's usually no trauma before the onset of pain. Septic arthritis can quickly cause extensive damage to the knee cartilage. If you have knee pain with any of these symptoms, see your doctor right away.

Other problems

Patellofemoral pain syndrome is a general term that refers to pain arising between the kneecap (patella) and the underlying thighbone (femur). [1][2] It's common in athletes; in young adults, especially those who have slight malt racking of the kneecap; and in older adults, who usually develop the condition as a result of arthritis of the kneecap.

Risk factors

A number of factors can increase your risk of having knee problems, including:

- **Excess weight.** Being overweight or obese increases stress on your knee joints, even during ordinary activities such as walking or going up and down stairs. It also puts you at increased risk of osteoarthritis by accelerating the breakdown of joint cartilage.

- **Lack of muscle flexibility or strength.** A lack of strength and flexibility can increase the risk of knee injuries. Strong muscles help to stabilize and protect your joints, and muscle flexibility can help you achieve full range of motion.
- **Certain sports or occupations.** Some sports put greater stress on your knees than do others. Alpine skiing with its rigid ski boots and potential for falls, basketball's jumps and pivots, and the repeated pounding your knees take when you run or jog all increase your risk of knee injury. Jobs that require repetitive stress on the knees such as construction or farming also can increase your risk.
- **Previous injury.** Having a previous knee injury makes it more likely that you'll injure your knee again.

Complications:

Not all knee pain is serious. But some knee injuries and medical conditions, such as osteoarthritis, can lead to increasing pain, joint damage and disability if left untreated. And having a knee injury — even a minor one — makes it more likely that you'll have similar injuries in the future.

Prevention:

Although it's not always possible to prevent knee pain, the following suggestions may help forestall injuries and joint deterioration:

- **Keep extra pounds off.** Maintain a healthy weight; it's one of the best things you can do for your knees. Every extra pound puts additional strain on your joints, increasing the risk of injuries and osteoarthritis.
- **Be in shape to play your sport.** To prepare your muscles for the demands of sports participation, take time for conditioning. Work with a coach or trainer to ensure that your technique and movement are the best they can be.
- **Practice perfectly.** Make sure the technique and movement patterns you use in your sports or activity are the best they can be. Lessons from a professional can be very helpful.
- **Get strong, stay flexible.** Because weak muscles are a leading cause of knee injuries, you'll benefit from building up your quadriceps and hamstrings, which support your knees. Balance and stability training helps the muscles around your knees work together more effectively. And because tight muscles also can contribute to injury, stretching is important. Try to include flexibility exercises in your workouts.
- **Be smart about exercise.** If you have osteoarthritis, chronic knee pain or recurring injuries, you may need to change the way you exercise. Consider switching to swimming, water aerobics or other low-impact activities at least for a few days a week. Sometimes simply limiting high-impact activities will provide relief.

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LITERATURE REVIEW

Knee pathology is one of the most common indications for musculoskeletal imaging. In particular, evaluation of meniscal lesions, whether of degenerative or traumatic origin, accounts for a large proportion of the knee examinations performed with magnetic resonance imaging (MRI).[3][4]Knowledge of meniscal pathology and MRI appearances of degenerative and traumatic meniscal lesions has advanced over the years. Studies on the performance of MRI with surgical correlation have identified the most frequently missed meniscal lesions, so that radiologists and arthroscopists know where actively search for meniscal diseases. Discussions among clinicians, surgeons, and arthroscopists have advanced the clinical knowledge of the "tricky" lesions that should be known by radiologists. After a brief review of the typical meniscal lesions, this paper describes these "must know" lesions.

To determine the indications for magnetic resonance imaging (MRI) in the evaluation of individuals with carpal tunnel syndrome (CTS). A critical review of the literature was undertaken. Among the studies reviewed, a lack of uniformity in MRI equipment and techniques, conflicting sensitivity and specificity of imaging criteria for median nerve compression, and a paucity of normative data were noted. Based on this review, [3] we conclude that MRI is not a useful tool for large-scale population screening, and is unhelpful as a routine preoperative study MRI is useful for

confirmed CTS with persistent postoperative findings and in cases m which anatomic anomalies are suspected preoperative!)'. The use of MRI for guiding treatment deosions in individuals with clinical signs and symptoms of CTS but with normal electro diagnostic studies remains undetermined.

Characteristics of meniscal pathology

Generally speaking, meniscal lesions manifest as: Tears, which are characterized by abnormal intrameniscal signal that extends to the meniscus surface;substance loss, wherein the meniscus loses its normal triangular shape; displaced meniscal fragments which may remain attached to the parent meniscus or break free from this meniscus.

MRI has high sensitivity and specificity for diagnosing meniscal tears. However, this diagnostic value is more limited for fragment detection. Hence, meniscal fragments must be actively searched for in the common locations of displacement.

Meniscal tear patterns:

MRI, a tear presents as an abnormal intrameniscal signal on T2-weighted or proton density MR images that unambiguously contacts the meniscal surface; that is the tear is visible on at least 2 consecutive slices or on 2 images acquired in different planes. These tears are categorized according to their patterns using the same classifications used by arthroscopic surgeons. Vertical tears are oriented perpendicularly to the tibial plateau. Vertical tears may be longitudinal (follow the long axis of the meniscus), radial (perpendicular to the long axis of the meniscus), or oblique/vertical flap (combination of radial and longitudinal also known as "parrot beak" tears). [4] Vertical tears, in particular posterior, peripheral, and longitudinal tears, are commonly caused by trauma. Horizontal tears are more typically caused by degeneration and contact with the meniscal articular surface. A pure horizontal tear divides the meniscus in half and runs parallel to the tibial plateau with the tear exiting at the meniscal apex. A true horizontal tear has also been referred to as a horizontal cleavage tear or a "fish mouth" tears, given the appearance at arthroscopy. A horizontal flap tear describes horizontally oriented tears that contact either the femoral or tibial articular surface rather than the meniscal apex. Lastly, complex tears show combinations of the patterns described below.

MRI is the modality of choice for evaluating meniscal pathology, observed either alone or in association with ligament injury in traumatic settings. MRI has high diagnostic performance and is noninvasive. The examination most commonly relies on the acquisition of two-dimensional (2D) thin slices in the axial, sagittal, and coronal planes. MRI increasingly relies on the acquisition of isotropic images using three-dimensional (3D) fast spin-echo sequences such as SPACE (Siemens-Healthiness, Erlangen, Germany), CUBE (GE Healthcare, Milwaukee, WI, USA), and VISTA (Philips, Eindhoven, The Netherlands), which can then be used for multiplanar reconstruction. Proton density–and intermediate-weighted with fat signal suppression are the best image weightings for detecting meniscal lesions. These sequences have the best performance and can be used to identify meniscal tears, displaced fragments, and indirect signs associated with migration. These sequences also have satisfactory performance for evaluating ligaments, cartilage, peri-articular soft tissues and postoperative changes.

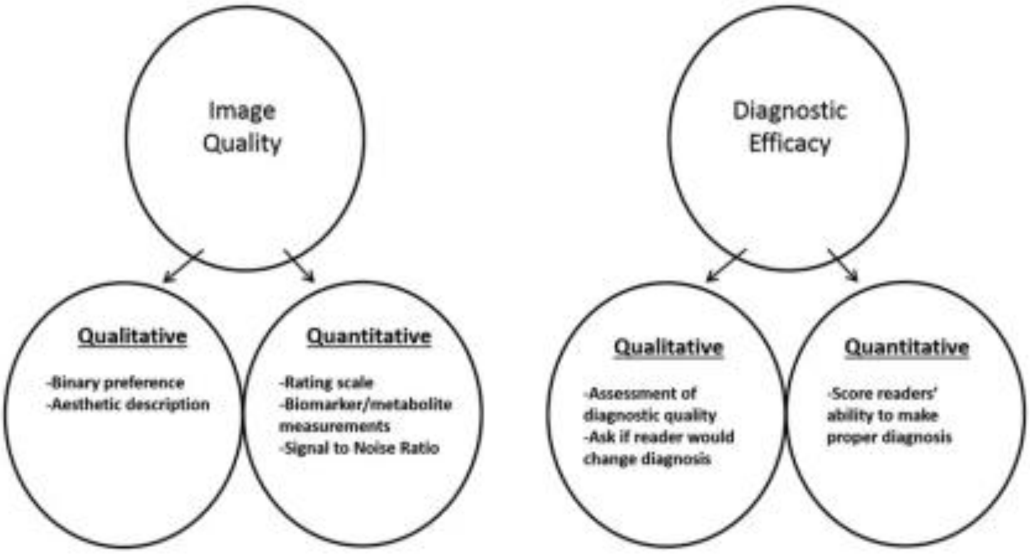


Figure.3 Qualitative or Quantitative assessment methods

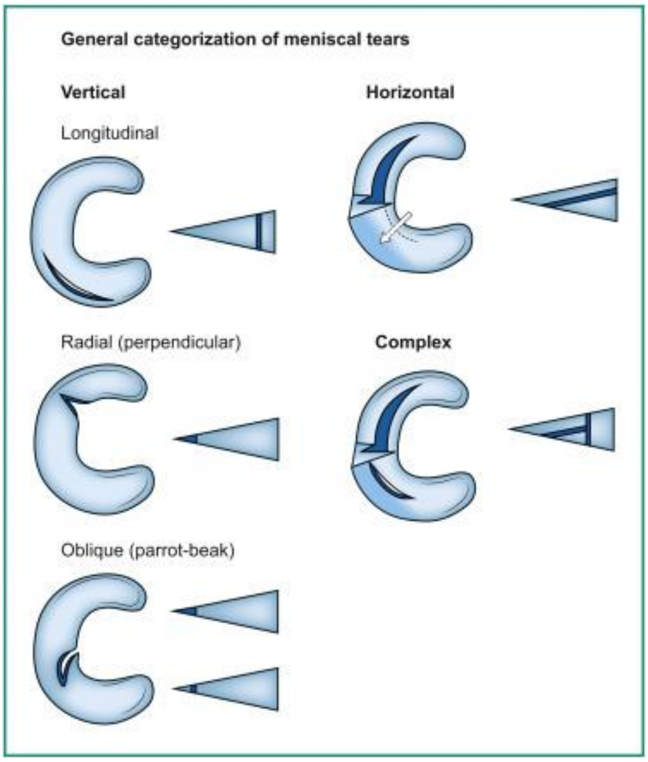


Figure.4 Illustrations of typical meniscal tears according to their orientation. Vertical tears may be longitudinal, radial, and oblique and are most often due to trauma. Horizontal tears are most often due to degeneration. Complex tears combine several orientations.

Scan the data from model segmentation challenge (MICCAI BraTS 2013) are utilized which is co- registered and the histogram matching is performed with a reference volume of high contrast.[5]From the preprocessed images, various features are extracted like intensity, intensity differences, local neighborhood, and wavelet texture; basic processing is performed using various filters for noise removal. The noised removed image is segmented, and the feature extractions are performed. Features are extracted using the wavelet transform. When compared to other methods, the wavelet transform is more suitable for MRI image feature extraction. The features are given to the classifier which uses binary tree support vectors for classification.

Suppose there are two categories, i.e., Category A and Category B, and we have a new data point x1, so this data point will lie in which of these categories. To solve this type of problem, we need a K-NN algorithm. [6] With the help of K-NN, we can easily identify the category or class of a particular dataset. Consider the below diagram:

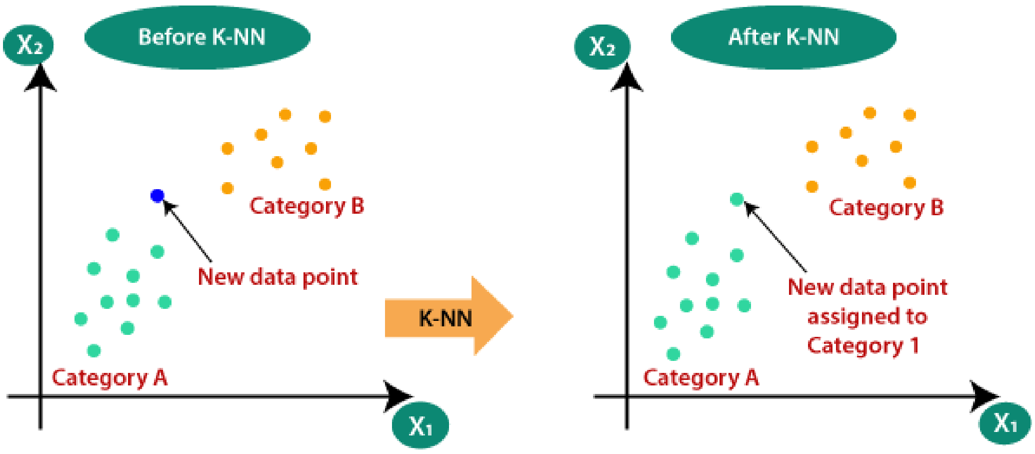


Figure.5 KNN MAPPING

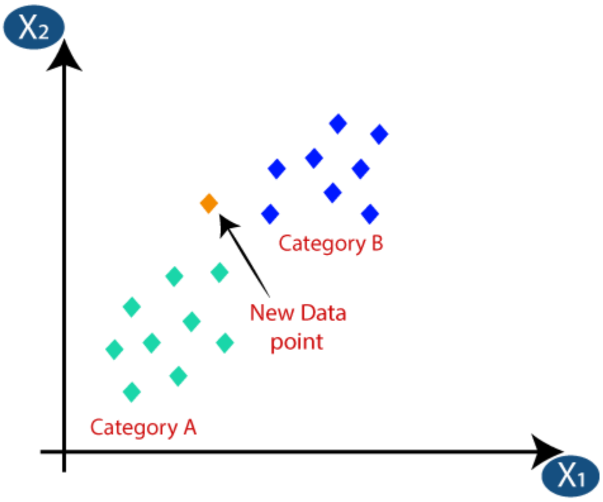


Figure.6 Data Point Collection

Firstly, we will choose the number of neighbors, so we will choose the k=5.Next, we will calculate the **Euclidean distance** between the data points. The Euclidean distance is the distance between two points, which we have already studied in geometry. It can be calculated as:

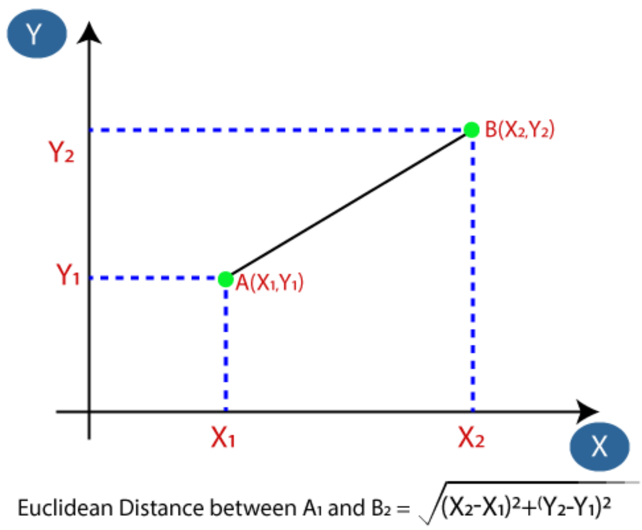


Figure.6 Distance Calculation

By calculating the Euclidean distance we got the nearest neighbors, as three nearest neighbors in category A and two nearest neighbors in category B. Consider the below image:

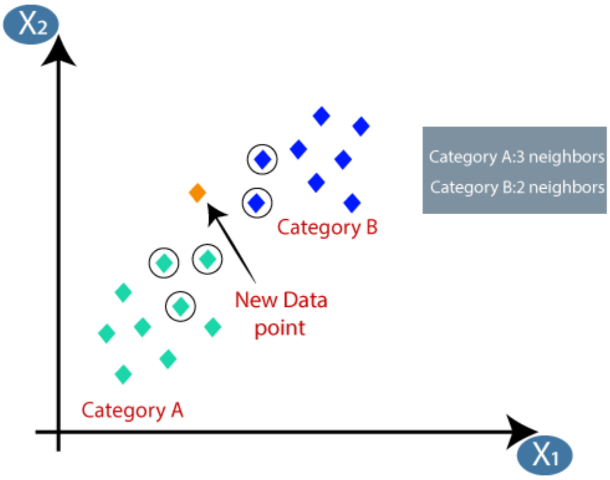


Figure.8 Neighbor data collection set

As we can see the 3 nearest neighbors are from category A, hence this new data point must belong to category A.Below are some points to remember while selecting the value of K in the K-NN algorithm:

There is no particular way to determine the best value for "K", so we need to try some values to find the best out of them. The most preferred value for K is 5.A very low value for K such as K=1 or K=2, can be noisy and lead to the effects of outliers in the model.Large values for K are good, but it may find some difficulties.

Advantages of KNN Algorithm:

1. It is simple to implement.
2. It is robust to the noisy training data
3. It can be more effective if the training data is large.

Disadvantages of KNN Algorithm:

1. Always needs to determine the value of K which may be complex some time.
2. The computation cost is high because of calculating the distance between the data points for all the training samples.

Python implementation of the KNN algorithm

To do the Python implementation of the K-NN algorithm, we will use the same problem and dataset which we have used in Logistic Regression. But here we will improve the performance of the model. Below is the problem description:

Problem for K-NN Algorithm: There is a Car manufacturer company that has manufactured a new SUV car. The company wants to give the ads to the users who are interested in buying that SUV. So for this problem, we have a dataset that contains multiple user's information through the social network. The dataset contains lots of information but the **Estimated Salary** and **Age** we will consider for the independent variable and the **Purchased variable** is for the dependent variable. Below is the dataset:

User ID	Gender	Age	EstimatedSalary	Purchased
15624510	Male	19	19000	0
15810944	Male	35	20000	0
15668575	Female	26	43000	0
15603246	Female	27	57000	0
15804002	Male	19	76000	0
15728773	Male	27	58000	0
15598044	Female	27	84000	0
15694829	Female	32	150000	1
15600575	Male	25	33000	0
15727311	Female	35	65000	0
15570769	Female	26	80000	0
15606274	Female	26	52000	0
15746139	Male	20	86000	0
15704987	Male	32	18000	0
15628972	Male	18	82000	0
15697686	Male	29	80000	0
15733883	Male	47	25000	1
15617482	Male	45	26000	1
15704583	Male	46	28000	1
15621083	Female	48	29000	1
15649487	Male	45	22000	1
15736760	Female	47	49000	1

Figure.9 Dataset value

Steps to implement the K-NN algorithm:

- ❖ Data Pre-processing step
- ❖ Fitting the K-NN algorithm to the Training set
- ❖ Predicting the test result
- ❖ Test accuracy of the result(Creation of Confusion matrix)
- ❖ Visualizing the test set result.

❖ Data Pre-Processing Step:

The Data Pre-processing step will remain exactly the same as Logistic Regression. Below is the code for it:

```
# importing libraries
import numpy as nm
import matplotlib.pyplot as mtp
import pandas as pd

#importing datasets
data_set= pd.read_csv('user_data.csv')

#Extracting Independent and dependent Variable
x= data_set.iloc[:, [2,3]].values
y= data_set.iloc[:, 4].values

# Splitting the dataset into training and test set.
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test= train_test_split(x, y, test_size= 0.25, random_state=0)

#feature Scaling
from sklearn.preprocessing import StandardScaler
st_x= StandardScaler()
x_train= st_x.fit_transform(x_train)
x_test= st_x.transform(x_test)
```

By executing the above code, our dataset is imported to our program and well pre-processed. After feature scaling our test dataset will look like:

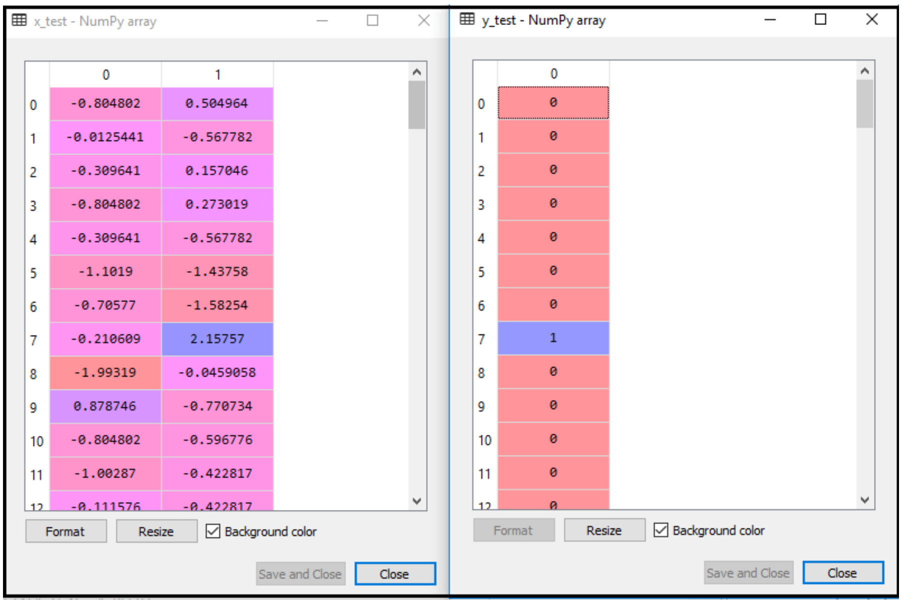


Figure.10 Dataset Execution

From the above output image, we can see that our data is successfully scaled.

- **Fitting K-NN classifier to the Training data:**

Now we will fit the K-NN classifier to the training data. To do this we will import the **KNeighborsClassifier** class of **Sklearn Neighbors** library. After importing the class, we will create the **Classifier** object of the class. The Parameter of this class will be

- **n_neighbors:** To define the required neighbors of the algorithm. Usually, it takes 5.
- **metric='minkowski':** This is the default parameter and it decides the distance between the points.
- **p=2:** It is equivalent to the standard Euclidean metric.

And then we will fit the classifier to the training data. Below is the code for it:

```
#Fitting K-NN classifier to the training set
from sklearn.neighbors import KNeighborsClassifier
classifier= KNeighborsClassifier(n_neighbors=5, metric='minkowski', p=2 )
classifier.fit(x_train, y_train)
```

Output: By executing the above code, we will get the output as:

```
Out[10]:
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=5, p=2,
                     weights='uniform')
```

Predicting the Test Result: To predict the test set result, we will create a y_pred vector as we did in Logistic Regression. Below is the code for it:

```
#Predicting the test set result
y_pred= classifier.predict(x_test)
```

Output:

The output for the above code will be

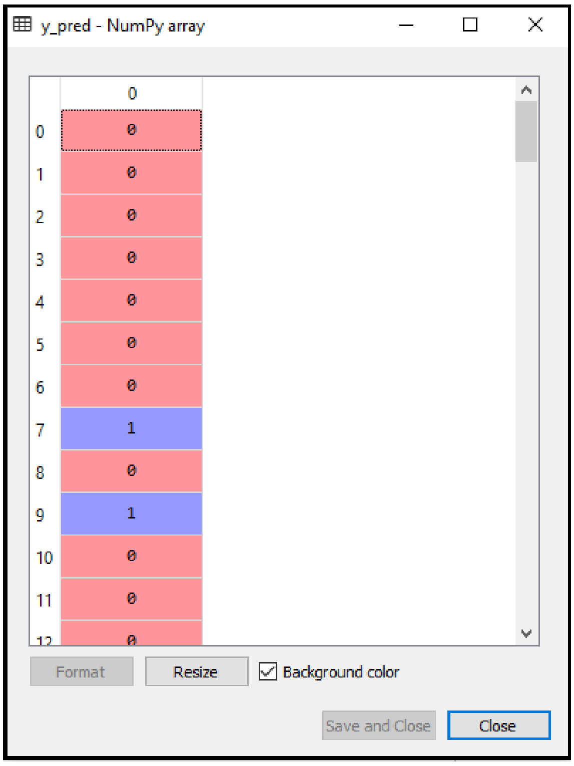


Figure.11 Output data set

- **Creating the Confusion Matrix:**

Now we will create the Confusion Matrix for our K-NN model to see the accuracy of the classifier. Below is the code for it:

```
#Creating the Confusion matrix
from sklearn.metrics import confusion_matrix
 cm= confusion_matrix(y_test, y_pred)
```

In above code, we have imported the confusion_matrix function and called it using the variable cm.

Output: By executing the above code, we will get the matrix as below:

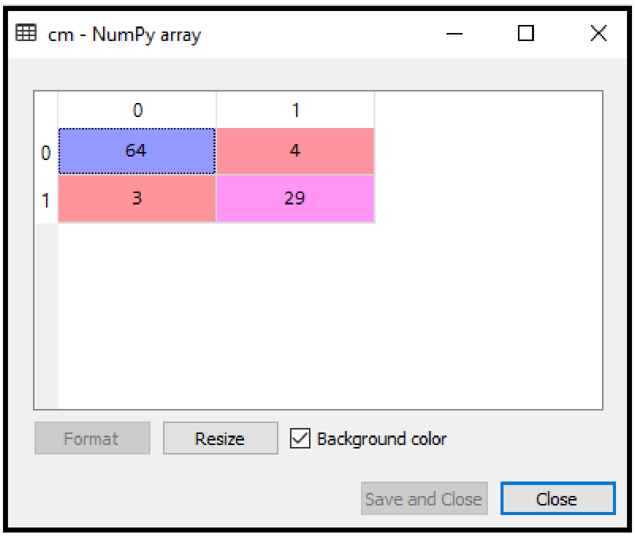


Figure.12 K-NN algorithm Estimated

In the above image, we can see there are 64+29= 93 correct predictions and 3+4= 7 incorrect predictions, whereas, in Logistic Regression, there were 11 incorrect predictions. So we can say that the performance of the model is improved by using the K-NN algorithm.

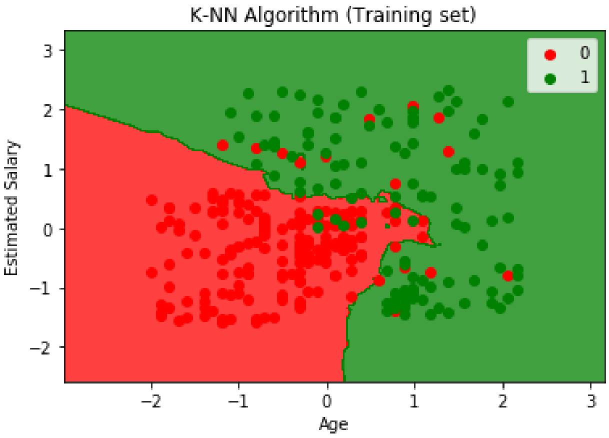
○ **Visualizing the Training set result:**

Now, we will visualize the training set result for K-NN model.[7] The code will remain same as we did in Logistic Regression, except the name of the graph. Below is the code for it:

```
#Visulaizing the trianing set result
from matplotlib.colors import ListedColormap
x_set, y_set = x_train, y_train
x1, x2 = nm.meshgrid(nm.arange(start = x_set[:, 0].min() - 1, stop = x_set[:, 0].max() + 1, step  =0.01),
nm.arange(start = x_set[:, 1].min() - 1, stop = x_set[:, 1].max() + 1, step = 0.01))
mtp.contourf(x1, x2, classifier.predict(nm.array([x1.ravel(), x2.ravel()]).T).reshape(x1.shape),
alpha = 0.75, cmap = ListedColormap(('red','green' )))
mtp.xlim(x1.min(), x1.max())
mtp.ylim(x2.min(), x2.max())
for i, j in enumerate(nm.unique(y_set)):
    mtp.scatter(x_set[y_set == j, 0], x_set[y_set == j, 1],
        c = ListedColormap(('red', 'green'))(i), label = j)
mtp.title('K-NN Algorithm (Training set)')
mtp.xlabel('Age')
mtp.ylabel('Estimated Salary')
mtp.legend()
mtp.show()
```

Output:

By executing the above code, we will get the below graph:



The output graph is different from the graph which we have occurred in Logistic Regression. It can be understood in the below points:

- As we can see the graph is showing the red point and green points. The green points are for Purchased(1) and Red Points for not Purchased(0) variable.
- The graph is showing an irregular boundary instead of showing any straight line or any curve because it is a K-NN algorithm, i.e., finding the nearest neighbor.
- The graph has classified users in the correct categories as most of the users who didn't buy the SUV are in the red region and users who bought the SUV are in the green region.
- The graph is showing good result but still, there are some green points in the red region and red points in the green region. But this is no big issue as by doing this model is prevented from overfitting issues.
- Hence our model is well trained.

Visualizing the Test set result:

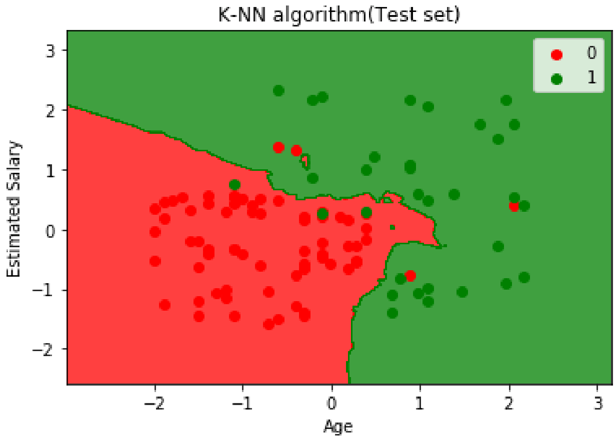
After the training of the model, we will now test the result by putting a new dataset, i.e., Test dataset. Code remains the same except some minor changes: such as **x_train and y_train** will be replaced by **x_test and y_test**.

Below is the code for it:

```
#Visualizing the test set result
from matplotlib.colors import ListedColormap
x_set, y_set = x_test, y_test
x1, x2 = nm.meshgrid(nm.arange(start = x_set[:, 0].min() - 1, stop = x_set[:, 0].max() + 1, step  =0.01),
nm.arange(start = x_set[:, 1].min() - 1, stop = x_set[:, 1].max() + 1, step = 0.01))
```

```
mtp.contourf(x1, x2, classifier.predict(nm.array([x1.ravel(), x2.ravel()]).T).reshape(x1.shape),
alpha = 0.75, cmap = ListedColormap(('red','green' )))
mtp.xlim(x1.min(), x1.max())
mtp.ylim(x2.min(), x2.max())
for i, j in enumerate(nm.unique(y_set)):
    mtp.scatter(x_set[y_set == j, 0], x_set[y_set == j, 1],
        c = ListedColormap(('red', 'green'))(i), label = j)
mtp.title('K-NN algorithm(Test set)')
mtp.xlabel('Age')
mtp.ylabel('Estimated Salary')
mtp.legend()
mtp.show()
```

Output:



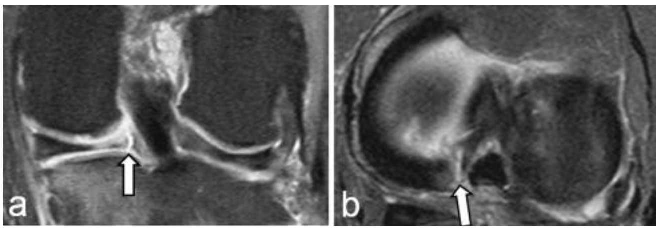
The above graph is showing the output for the test data set. As we can see in the graph, the predicted output is well good as most of the red points are in the red region and most of the green points are in the green region. However, there are few green points in the red region and a few red points in the green region.[8] So these are the incorrect observations that we have observed in the confusion matrix (7 Incorrect output).

2D Wavelet Transform and Spatial Gray Level Dependence Matrix (DWT-SGLDM) is used for feature extraction for feature selection; Simulated Annealing (SA) is applied to reduce features size. The next step is Stratified K-fold Cross- Validation to avoid over-fitting. To optimize the support vector machine (SVM) parameters, the Genetic Algorithm is used with Support Vector Machine (GA-SVM) model. SVM is used to construct the classifier.

A new hybrid technique based on the support vector machine (SVM) and fuzzy c-means for Knee tumor classification are proposed, In this paper, the image is enhanced using enhancement techniques such as contrast improvement, and mid-range stretch. Fuzzy c-means (FCM) clustering is used for the segmentation of the image to detect the suspicious region in the Knee MRI image.

A hybrid feature extraction method with a regularized extreme learning machine (RELM) for developing an accurate Knee tumor classification approach is done, The approach starts by pre-processing the Knee images by using a min-max normalization rule to enhance the contrast of Knee edges and regions.[9] Then, the Knee tumor features are extracted based on a hybrid method of feature extraction. Finally, RELM is used for classifying the type of Knee tumor.

MRI technique contains many imaging modalities that scan and captures the internal structure of the human Knee, noise removal technique, extraction of gray-level co- occurrence matrix (GLCM) features,[10] DWT based Knee tumor region techniques are mainly concentrated to reduce the complexity and improve the performance, an automated method is proposed to differentiate easily between cancerous and non-cancerous MRI of the Knee. Different techniques have been applied for the segmentation of candidate lesions.[11] Then, the Support Vector Machine (SVM) classifier is applied with different cross-validations on the features set to compare the performance of the proposed framework.



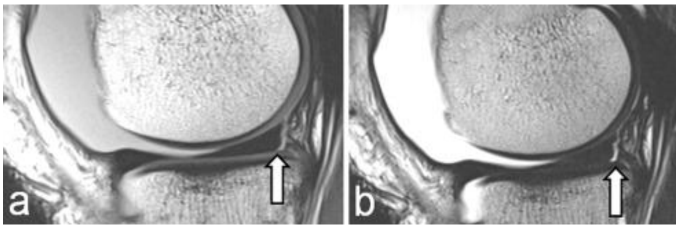


Figure.14 Before and after segmentation

1. Shape Features-circularity, irregularity, Area, Perimeter, Shape Index
2. Intensity features–Mean, Variance, Standard Variance, Median Intensity, Skewness, and Kurtosis Texture features–Contrast, Correlation, Entropy, Energy, Homogeneity, cluster shade, sum of square variance. Accordingly, 3 kinds of features are extracted, which describe the structure information of intensity, shape, and texture. However these features will have redundancy to remove that we are going for feature reduction.

Feature Reduction

More number of features increases the computational time and memory storage and hence makes the classification of images more complicated. [12] Principle component analysis (PCA) is an efficient tool to reduce the dimension of a data set consisting of many variables correlated with each other, either heavily or lightly, while retaining the variation present in the dataset, up to the maximum extent. PCA is one of the most used linear dimensionality reduction technique. When using PCA, we take as input our original data and try to find a combination of the input features which can best summarize the original data distribution so that to reduce its original dimensions. PCA can do this by maximizing variances and minimizing the reconstruction error by looking at pair wised distances.

Classification and K-Fold Cross Validation

Based on the extracted reduced features, the type of tumor is identified using classification techniques. In the proposed work, [13] we have used KNN and SVM classifier models are used. Instead of holdout partition, we have applied 5-fold cross-validation because of its properties as simple, easy, and utilizing all information for training and validation. [14] We have taken an average accuracy level obtained from the 5-folds with and without smote sampling technique. The obtained results are plotted in Figure 5. It is very clear that the performance of the proposed system is enhanced when applying the smote sampling method.

Conclusion

In this paper, we proposed an efficient technique that combines the discrete wavelet rework (DWT) with Principle Component Analysis (PCA) to classify the Knee MRIs into Normal affected one. Image thresholding has been applied for segmentation purpose. The proposed work is tested with KNN and SVM classifier models. To balance the samples in the dataset classes, SMOTE sampling technique has been adopted. This helps to improve the proposed model's classification accuracy by 3.4% on an average. In future, we have planned to apply this SMOTE sampling with other medical datasets and with different classification algorithms.

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