Mapana – Journal of Sciences
2023, Vol. 22, Special Issue 2, *379-396*
ISSN 0975-3303 | https://doi.org/10.12723/mjs.sp2.22

Early Prediction of Liver Problems Using Knowledge Mining Techniques

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Abstract

Knowledge Mining methodologies in healthcare have already come across in medical imaging solutions and chatbots. These results however can help to identify the patterns in different sectors of patients with their symptoms. I foresee some of the Knowledge Mining algorithms are capable of identifying the possibilities or the probabilities of getting cancer, and imaging solutions and rare diseases or specific types of pathology. The algorithms of knowledge mining are exists as Deep learning methodologies that has started emerging as a prominent technique in providing medical professionals with insights that lets them predict issues early on, thereby delivering far more personalized and relevant patient care. Subsequent to my groundwork of research in imposing Data Mining and its techniques in identifying Liver infections, I foresee the deep learning methodologies will play a second fiddle in making my research works meaningful. Adding more value to the POCs that I implement as a part of my research, I explore the Deep learning applications and how they can be used in various health records of a person to determine whether he is prone to Liver infection. The future of healthcare is heading to be more exciting than we expect. Not only do AI and ML present an opportunity to develop solutions that cater to very specific needs within the industry, but deep learning in healthcare can be more supporting clinicians and transform patient care at their door step. Does all this tend to indicate that deep learning is going to be the future of healthcare? The answer is biased as there are equal challenges kept wide open to address to

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take full advantage of the benefits of Deep Learning. Ultimately, the techniques or the algorithms that support the medical challenges are becoming increasingly capable to integrate AI-based algorithms that can rationalize and shorten complex data analysis and improve verdicts. It can be trained as well as it can be equally learned. It can also reduce the reporting delays which are termed to be a normal excuse in present days and improve the transparency in the workflows. This effect is used to shift the milestones and benchmarks of patient care promptly and budget-strapped economy.

Keywords: Artificial intelligence. Deep learning. Convolution Neural Network CNN. Self-Organizing Maps SOM. Best Matching Unit BMU. Deep Belief Networks DBN. Autoencoders. Centroid. Clustering.

1. Introduction

Knowledge Mining is a methodology that implies the healthcare industry in various dimensions. One prominent aspect is that deep learning helps to analyse the raw data at exceptional speeds. This achievement results without compromising accuracy for any reason. All of these are not a part of machine learning or Artificial Intelligent. Perhaps, this is an elegant assortment of analytical and technical data that resides in a layered algorithmic architecture. Most of the emerging architecture that looks to meet the analytical challenge turns towards Deep Learning techniques for their solution. Specifically, in the healthcare field, the benefits of deep learning are plentiful such as the fast, efficient, and accuracy – but they don't stop there.

Knowledge Mining in the form of deep learning depends on the arithmetic models which have the approach of algorithm-based working to execute an IoT-based model. There exist multiple layers of the network as well as the technology for computing capability. These are unprecedented and are enough for the ability to quantify the data that was previously been lost, forgotten, or missed. These knowledge-mining algorithms or networks can also be capable to solve complex problems and ease out the predictions within the healthcare profession. It's a skill set that hasn't gone unnoticed by the healthcare profession.

Knowledge Mining in healthcare will not end here, it continues to make good inroads into the other industry too, especially now that there are more medical professionals who seek for recognizing results. For them, this technology and algorithm can benefit more in bringing accuracy from intense collaboration with their industry and specialization. It tends to maintain the agility and capability to adapt ensuring that it always remains relevant to the profession.

2. Knowledge Mining Algorithms

The knowledge mining algorithms are capable of featuring as a self-learning representation. They often depend on ANNs which usually mirror the way exactly how the brain computes information. During the training process, not only the deep learning algorithms but also the most commonly used algorithms are considered unknown elements. Especially in the input distribution extracting the features, attributes, group objects, and generic parameters that discover useful data patterns. Much like the most commonly used training machines for self-learning techniques, these algorithms or working approaches occur at multiple levels [1]. These workings are then used to build the models.

Knowledge mining models work by adhering to several algorithms such as deep learning algorithms. Subsequently, there are no networks that are foreseen to be perfect in meeting the expected results, some algorithms seem to be better suitable for performing specific tasks. To choose the right algorithm, it's recommended to gain a concrete understanding of all primary algorithms.

2.1 Various Knowledge Mining Algorithms

Below are the various knowledge-mining algorithms that exist in the research platform. In this paper let us focus on the top four among them [1].

- Convolutional Neural Networks (CNNs)
- Long Short-Term Memory Networks (LSTMs)
- Recurrent Neural Networks (RNNs)
- Generative Adversarial Networks (GANs)
- Radial Basis Function Networks (RBFNs)
- Multilayer Perceptrons (MLPs)
- Self-Organizing Maps (SOMs)

- Deep Belief Networks (DBNs)
- Restricted Boltzmann Machines (RBMs)
- Autoencoders

Knowledge Mining algorithms are capable to implement in almost all formats of data and do not consume a large volume of computing power. At the same time, it does have information enough to solve complicated issues. Moving forward in this paper, let us, deep-dive, into the above-listed knowledge-mining algorithms

Convolutional Neural Networks (CNNs). CNNs, are referred to as ConvNets, which are composed of multiple layers and are prominently used for image processing techniques and object detection methodologies. In the year 1988, the first CNN was developed by Yann LeCun. By that time, it was named and called as LeNet. It was utilized first for recognizing characters like Postcodes in ZIP format and digits[1].

CNNs are mostly used to locate satellite images, process medical-related images, forecast the time series, and to detect any anomalies.

Working of CNNs. Mostly the CNN's follow the multiple layers approach that process and extract common features from data:

Convolution Layer. CNN has a convolution layer. This layer contains several filters to apply the convolution operation.

Rectified Linear Unit (ReLU) CNNs also contains a ReLU layer. This supports performing the operations that require consistency and many iterations on certain elements in the data set. The output of this step tends to a rectified feature map.

Pooling Layer. The sequence of rectified feature maps is then fed into the next layer named a pooling layer. Pooling is termed to be a downstream sampling operation that usually helps to reduce the dimensions of the needed feature map.

The pooling layer mostly converts the two-dimensional arrays of results from the pooled feature map to form a single, continuous, linear vector perhaps the long one by flattening it at times [1].

Fully Connected Layer. A fully connected layer is approached when the flattened form of the matrix from the previous pooling layer is fed as a preferred input to this step, which often identifies and classifies the observed images.

Long Short-Term Memory Networks (LSTMs)

The Long Short Term Memory Networks commonly termed as LSTMs symmetrically belong to a Recurrent Neural Network (RNN) model. This type of network algorithm is capable to learn and memorize (with stand) long-term dependencies over some time. This means recalling past information from a wide range of data sets for long periods [1].

LSTMs retain information in the long run. They are perhaps useful in real-time time-series prediction for the reason they are now remembered mostly on previous inputs. LSTMs are chain-like structures consisting of four interacting layers. All those layers communicate uniquely. Besides the time-series predictions, LSTMs are typically imposed in symptom recognition and similarity findings among the patients with common attributes [1].

How Do LSTMs Work?

Step-1: Initiates with the forget irrelevant chunks of the previous state.

Step-2: Selectively update the cell-state values of each chunk

Step-3: The output of certain chunks of the cell state is recognized with its generic parameters.

Recurrent Neural Networks (RNNs).

Recurrent Neural Networks are common terms as RNNs. This algorithm has connections that cordially form directed cycles.[2] This streamed structure allows the outputs from the LSTM technique to be fed as inputs to the RNNs' current phase.

The output from the LSTM algorithm is been fed as the input to the RNNs' current phase and this, in turn, can extend to memorize the data in previous inputs due to its magnified internal memory. RNNs are most commonly used for pattern identification from patients and help to predict the probability of getting cancer-based on the previous patient who has been already affected by cancer and those records are in memory as per this current phase. This is the scenario where these algorithms help in improving cancer predictions in the medical industry based on past historical data.

Working of RNNs.

Step-1: The output at a stipulated time 't-1' is fed into the input at a time 't'.

Step-2: Similarly, the output at the manipulated time 't' is fed into the input at a time 't+1'.

Notable Behaviour: RNNs are capable of processing inputs of any length.

One prominent observation I propose to highlight in this chapter of RNNs working is the computation nature of accounts for the historical information involved in this algorithm, and the expected model size of the algorithm does not increase with the input size[2].

Generative Adversarial Networks (GANs).

Generative Adversarial Networks termed as GANs are commonly a technique for generative deep learning algorithms. This algorithm creates new data instances which resemble the extracted training data. GAN has segregated into two components: the first is a generator, which learns to generate fake data, and the second is a discriminator, which learns from that false information[3].

The GANs usage has increased over some time. They can be prominently used to improvise astronomical images and articulate the gravitational lensing for much dark-matter research. CT Scan in medical investigation uses the GANs to upscale the low-resolution of the infected lung.

GANs help the physician to predict the possibility of a patient getting infected by cancer. The

common parameters among the findings generate realistic results. One can keep preserving the results of RNN to compare and study the predictions with the help of GANs result in a comparison.

How Do GANs work? To impose the GANs algorithm working, one has to learn the capability of distinguishing the differences between the GANs fake data and the actual history of past data.

At the initial phase of training, the GANs generator creates fake data, and the discriminator learns to tell that it's false at a sooner time interval [3].

As a final step of working, the GAN passes the results to the generator as well as the discriminator intimating to update the data model.

3. Preliminary Investigation on Liver Problem

The liver is the only organ in the human body with the ability to regenerate by itself. It is the largest solid organ in the human body. Most infection of the liver is due to the unawareness of health concerns in food. perhaps, it can recover to its original health when infected but to a certain limit, and depending on the level of infection it gets damaged. The objective of my research paper is to bring out the methodologies that help to identify and foresee the problems that impact the liver so that patients can take medications at the right time to save their lives and bring happiness to many lives.

3.1 Common Liver Infections

Based on my groundwork with many healthcare institutes and real-time data, I have observed some of the commonly occurring liver diseases as below.

- Hepatitis A, B, & C as these are the predominant viral infection diseases.
- Consumption of excess alcohol, drugs, or even poisons if inhaled as a gas or internal consumption. Examples might refer to fatty liver disease and diseases like cirrhosis.
- The most anticipated problem 'Liver cancer'.
- Inherited diseases, such as hemochromatosis

3.2 Stages of Liver Infection.

As per observation with the records of patients under medication, the liver gets to cross over different stages of infections leading to the complete downfall at the end.

- Inflammation
- Cirrhosis
- Fibrosis

- End-stage liver disease
- Liver Cancer

4. The Approach to Problem Definition

The initial step of my approach to defining a saturated problem starts with identifying the patients who are prone to the risk of getting a liver infection. The challenge in this is to extract real-time data involving both the persons with good health and with medication. This helps me to segregate the data that tends to symptoms of a healthy and unhealthy liver. Below is my primary objective for this research paper.

- To Identify the critical feature selection.
- To increase the prediction accuracy.
- To identify and eliminate missing values using the probability method.
- To analyse for reducing the time-consuming techniques.
- To implement the prediction algorithm in Liver infection

This liver infection can be observed generally in stout patients. Upon evaluating the results from a variety of tests, scans, exams, and imaging methods one can help to identify and evaluate people affected by this condition.

5. The Strategy of Algorithm Implementation

In the experimental study of identifying the liver infection, we used acquired ultrasound images collected from 55 patients admitted for bariatric surgery in different health care centers and hospitals (this includes the average age of 45, 25% male, Body Max Index (BMI) close to 35).

Below are the five major strategies [3] that I propose to implement the knowledge mining algorithms as shown in Fig-1.

Familiarize – Identifying new concepts as a part of learning and developing a broad understanding of the challenge or the problem that resides in it.

Connect – Connect the new information co-relating to the problem and its real-time scenarios.

Apply – Begin to apply the knowledge and check for the predicted results, and iterate this process until a saturated result is noticed.

Analyse – Scrutinize the problem and break it into chunks so that the solution shall be arrived at individually to meet the proposed results.

Evaluate – This is the final step to look back at the approach and do the assessment on alternatives for better results.'

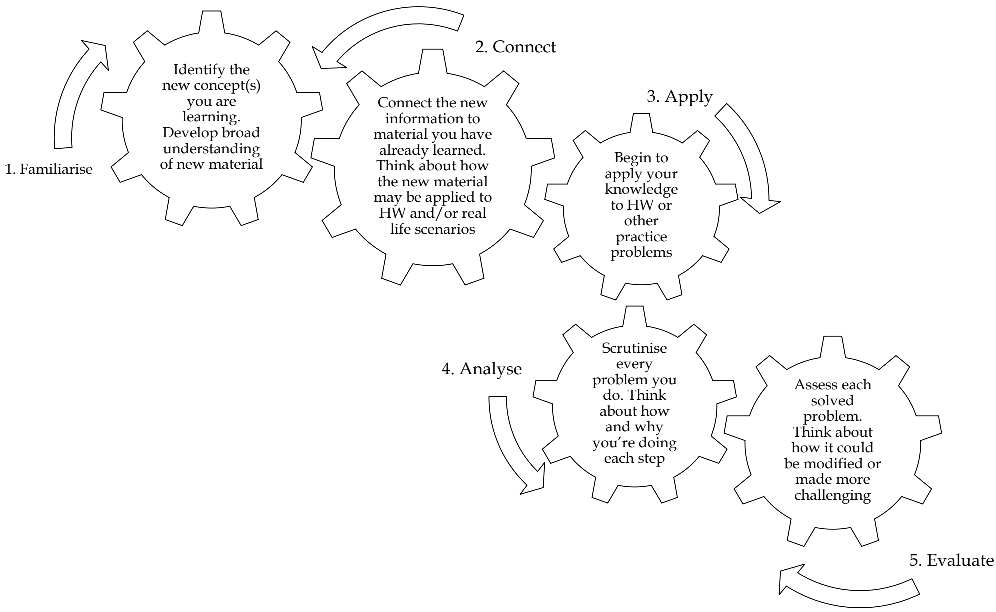


Fig. 1. Strategies for implementing the Knowledge Mining Algorithm

6. Research Methodology

The research methodology is divided into three major phases which are then further divided into various chunks of pre-processing steps [4].

Phase 1: Noise Removal
Data Pre-Processing
Centroid-based clustering over sampling method
Phase 2: Feature Selection
Hybridization of simulated annealing
Ant Colony Optimization
Phase 3: Deep Learning Method
Genetic Neural Network with long short-term memory

6.1 Over Sampling

The Over Sampling method is one of the preprocessing activities carried out before each of the three phases that was listed in the previous section. The data imbalance is one of the predominant challenges that researchers are facing in recent days when dealing with real-time data. This is also a major reason for performance degradation in algorithms [5]. Over-sampling helps to normalize this imbalance and reduce the uneven number of instances by a significant difference. To minimize the degree of imbalance data mining and feature space geometry have to be incorporated. Most of the machine learning classification problems are solved using the over-sampling process. In this paper, I propose to apply Centroid based clustering for over sample.

6.2 Centroid based Clustering

Centroid-based clustering ahead of the algorithm's input processing helps to locate the exact clusters. Here the clusters I refer to the identity (K value) in the algorithm for segregating a healthy and unhealthy liver from the given set of test result data. The process of centroid-based clustering involves the below sequence of steps[5].

- Finding the K Centroids (aligning to the number of groups) refers to the parameters in the patient's test results.
- Place the K value as much as possible far away from each other. This will reduce the redundancy in outliers removal.
- Samples with the same nearest centroid were included in the same group.
- Iteratively minimizes the sum of distances from each object to centroid to clusters.

7 Algorithm Execution

The algorithm execution initiates with the readiness of the scan reports, and test results extracted from the patients of different age groups and gender irrespective of the diagnosis. The raw data is first pre-processed to get structured data in an executable format. The input of data to the algorithm shall be placed in a file format and uploaded for compilation. The algorithm execution steps[5] are as follows.

Step 1: Read the Data for Liver Cancer (input file uploaded with the data)

Step 2: Find the missing element and replace it.
Step 3: Pre-process the Minority and Majority Cases
  Find Nearest Instance
  Find the label and data that most far from the nearest instance
  Remove the irrelevant data
Step 4: Group the minority label
  Find the Distance of Data Points
  Find the distances between all pairs of clusters
  Combine the nearest cluster based on Cluster distance
  Find the distance of the nearest cluster to other clusters
  Check if any majority cluster between them or not
  Merge the Minority cluster
Step 5: Find how many samples to be oversampled for the minority cluster
  Generate random members for minority cluster
  Split each minority cluster and put some portion of each in the fold matrix
Step 6: Oversample the minority clustered data by the centroid
  Find centroid based on majority and minority features
  Find unique samples based on centroid
  Generate new samples based on the nearest sample features
  Add new features and labels.

Since the research is intended to solve one of the burning issues in health science in reading the Liver Infection, the depth of knowledge mining algorithms are examined in all real-time application scenarios in health care sector and derived the algorithm execution. This is a kind of data mining framework that operates efficiently when both cost and accuracy functions are considered. The proposed model using Centroid-based clustering for knowledge integration is expected to work with great efficiency. The important advantages of my approach are as follows,

- Protection of locally arrived results' weight on a global level.
- The hybrid model shall bring more optimized results which reduce the complexity which in turn reduces the computational cost.

I centroid based clustering algorithm, a rotation matrix R performs the rotation of the points in the Euclidean space. In the round-robin process, the vector variable often contains the co-relativity of each circuit point that was pre-defined or declared as a dynamic placeholder. The coordinates pair for a two-dimensional plane shall be preset as x,y whereas for a three-dimensional plane, it shall be present as x,y,z as a point. The coordinates x, y, and z correspond to the x-axis, y-axis, and z-axis respectively. With this understanding, one can extend the coordinates if the dimension increases. For example, a four-dimensional plane can have the variable 'w' in addition to the three variables declared earlier x,y, and z. Probably when the matrix multiplication is represented for the above re-defined dynamic variables, then the vector denotations [R]and [V] can be formulated as directly proportional to each other's value. This is shown in Eq. (1) below. For further derivations and algorithm extensions, equation (1) shall be kept as a rotation matrix with the denotation [V']:

$$[V'] = [R] \times [V] \qquad (1)$$

When the scenario is altered for four-dimensional rotation, then the transformation of the equation (1) can be a simple rotation that consists of only one place of rotation matrix to derive the equations (2), (3).

The given matrix fixes the xy-plane, and zw-plane becomes the plane of rotation, points in zw-plane are rotated by an angle as shown in Eq. (2):

Probability[F] factors on people = [X]frequency times the Y * ZW/R[V] number of attempts symptoms are noticed and is considered as Equation-2 (2)

The given matrix fixes the zw-plane, and xy-plane becomes the plane of rotation, points in xy-plane are rotated by an angle shown below in the Equation. (3):

$$[\mathrm{R}] = \left\{ \begin{matrix} \mathrm{Fact} - 1 & \mathrm{Symptoms} - 1 & \mathrm{Frequency} \\ \mathrm{Fact} - 2 & \mathrm{Symptoms} - 2 & \\ \mathrm{Fact} - 3 & \mathrm{Symptoms} - 3 & \end{matrix} \right\} \quad (3)$$

In double rotation [5], we rotate the points along both the axis. For each plane, the angle of rotation is different. The plane of rotation and angles for double rotation is unique.

$$[R] = \begin{bmatrix} cos\beta & -sin\beta & 0 & 0 \\ sin\beta & cos\beta & 0 & 0 \\ 0 & 0 & cos\alpha & -sin\alpha \\ 0 & 0 & sin\alpha & cos\alpha \end{bmatrix} \quad (4)$$

The above is considered to be the Equation-4
The given matrix performs the double rotation along xy-plane and zw-plane with the angles of rotation and as shown in Eq. (4).

The below Algorithm presents the detailed steps for transforming different evaluation metrics for a student as attributes using four-dimensional rotation transformation.

Input: Dataset M, M- here refers to the different evaluation metrics that an institution offers. This may be food habits, sleeping hours, work environment, residing place etc.

Output: Perturbed Dataset MP. The MP here refers to the scorings in each metric that a student performs and the prediction factor for an individual

Begin
Read the data attributes from .csv file M (since the evaluation metric differs with each institution, it can be maintained in an excel file of CSV format)
Normalize (attribute)
Divide data into sets containing four elements each
Select the security threshold for each set V.
For each set
For values of
and
running from 0o to 360o

1.Compute: M′
[V′ (Au′, Av′, Aw′, Ax′)] = [R][V(Au, Av, Aw, Ax)]*
2. Compute Variance = M – M′
3. Plot a 3D graph between Variance and angles alpha and beta.
End for
End for
Select the angles alpha and beta such that variance at alpha and beta is maximum.
Compute perturbed data set MP at these angles obtained in the above step using the equation.
[V′ (Au′, Av′, Aw′, Ax′)] = [R][V(Au, Av, Aw, Ax)]*

End
People with drugs and alcohol consumption hold the symptoms probability greater than 60%
Persons with improper food habits in their personal life are below average than the defined metric.
Genetic disorder cause plays a major role in the results when changed.
Using the benefits of both supervised and unsupervised learning will give more efficiency in terms of accuracy.

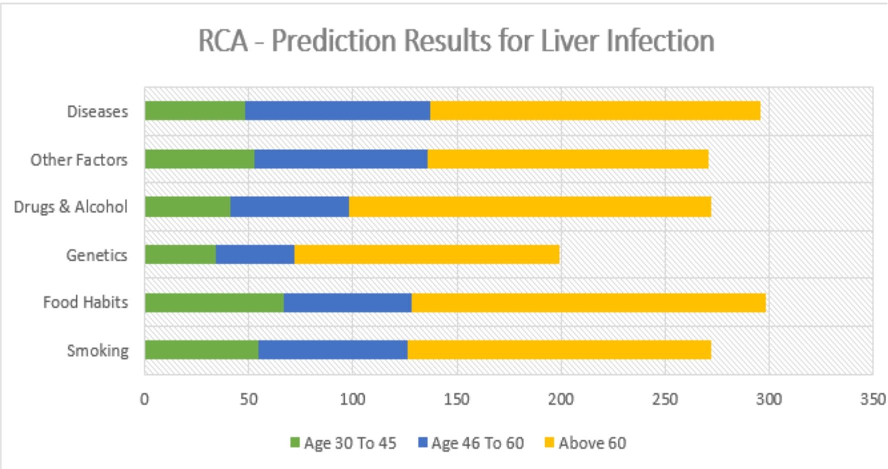


Fig. 2. Results after algorithm execution and over sampling data for prediction

8 Complications in Knowledge Mining Algorithm

Knowledge Mining algorithms most often demand the training of large sets or labelled data. This refers to an alternate way that we have to give the input parameters as thousands of actual images of patients scanning reports of an infected liver before it starts the processing of classifying infected and healthy liver with relative accuracy. The more the training data set, the better the outcome or classification performance of the algorithm improves. Big hospitals and labs are aware of this requirement in maintaining more data and are willing to offer that to serve better for their patients. The more classified information they have in this approach, the better they'll be able to train their knowledge-mining algorithms [6]. Perhaps, this could in turn make their services more effective and efficient than those of their competitors and gain more reliability among the patients. Though there exist lots of benefits in implementing Knowledge Mining or Deep Learning algorithms, there are some notable challenges that we have to come across to taste successful implementation

8.1 Perfection of Input Data Structure

It is hard to deliver every labeled data of a problem space to a knowledge mining algorithm. However, it is possible to generalize and then interpolate among their previous samples. This is done to classify data that these algorithms never faced before such as a new file, data, image, or sound that is not a part of its usual or declared dataset [6].

So this makes it more challenging to know when the defined knowledge mining algorithm doesn't have proper or enough training data in quality? It fails spectacularly, such that mistaking a liver in medication as infected or a liver transplant might take some time to get synced with the DNAs perhaps the algorithm predicts it as infected.

The heavy dependence on accurate and abundant data perhaps makes knowledge-mining algorithms vulnerable to deception.

8.2 Knowledge Mining is Shallow

A notable problem often the research scholars face with knowledge mining algorithms is that they're very accurate in mapping inputs to outputs but not the same accurate and good at understanding the context of the input or the output data they are dealing with or meant to be handling. The phrase "knowledge" in mining is often a reference to the simplified architecture of the data-based technology and the depth as well as the number of hidden layers the algorithms contain rather than a citation to its depth of understanding about what it does [7]

8.3 Knowledge Mining is Impervious

Those decisions that are driven by rule-based engines or workflow engines in functional operating software, shall be possibly traced back to the first node through if and else, perhaps, the same cannot be the case in the machine learning and deep learning algorithms. This is somehow termed as a lack of transparency in the research market. This lack of transparency in deep learning is what we term the "black box" type of problem.[7] Knowledge mining algorithms examine the huge volume of (millions) of data points to identify the patterns and associations that promptly go unobserved by research scholars. The decision finally the researchers make should be based on these findings often confound even the mentors who guided them.

This should not be a concern when it comes to deep learning. When the knowledge mining algorithm performs an inconsequential task where an abnormal or incorrect decision might cause little or no damage. But when it is a matter of deciding the fate of a defendant in court or the medical treatment of a patient, mistakes can have more serious repercussions.

9 Algorithm Results

Considering the execution of various algorithms of centroid-based clustering models, the accuracy is measured in a comparative representation as shown below.

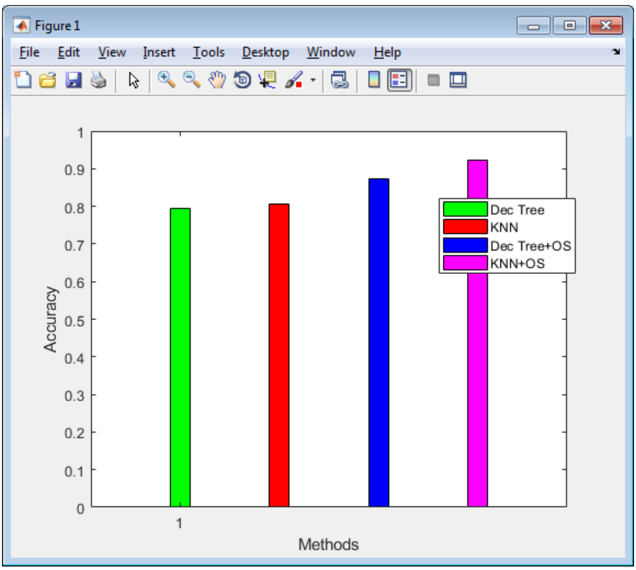


Fig. 3. Accuracy of different centroid clustering algorithms

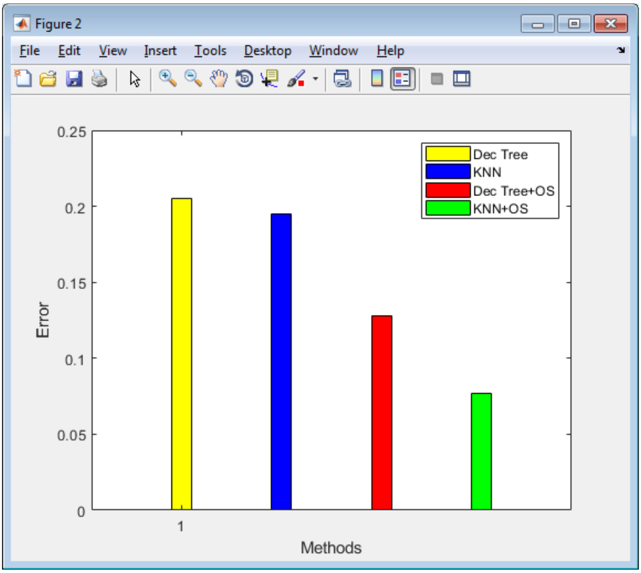
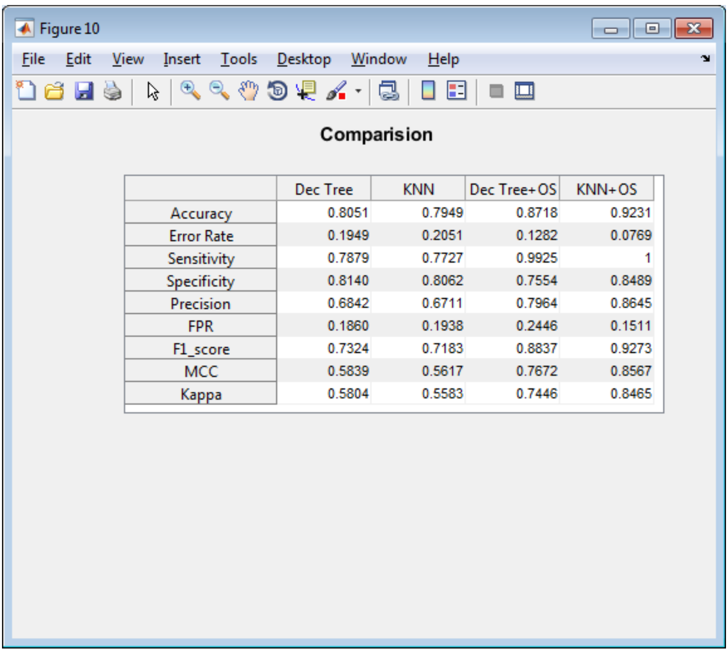


Fig. 4. Error occurrence ratio in different centroid clustering algorithms



	Dec Tree	KNN	Dec Tree+OS	KNN+OS
Accuracy	0.8051	0.7949	0.8718	0.9231
Error Rate	0.1949	0.2051	0.1282	0.0769
Sensitivity	0.7879	0.7727	0.9925	1
Specificity	0.8140	0.8062	0.7554	0.8489
Precision	0.6842	0.6711	0.7964	0.8645
FPR	0.1860	0.1938	0.2446	0.1511
F1_score	0.7324	0.7183	0.8837	0.9273
MCC	0.5839	0.5617	0.7672	0.8567
Kappa	0.5804	0.5583	0.7446	0.8465

Fig. 5. Comparison of different metrics between different centroid clustering algorithms

10 Conclusion

With this, let me conclude by stating that a new approach for identifying or predicting liver infection is through knowledge mining or deep learning algorithms. This is achieved through the implementation of pre-trained centroids for the classification of the acquired ultrasound images of the liver textures. The proposed approach demonstrates the working logic of all the available deep learning algorithms. Then comes the accuracy, performance, and independence of the method from the real-time patient records. In this paper with this approach, the results of different deep learning algorithms were evaluated, compared, and examined, based on their flexibility of implementation approach, user-friendly to the medical experts, accuracy, and performance. The results of this study show that the proposed pre-trained centroid-based clustering can be used by both medical experts and patients in knowing the liver infection as early as possible with high accuracy. To the tech experts in the medical labs to classify ultrasound images of the liver as normal or infected.

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