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Privacy and Security aspects of COVID 19 Image in Big Data Era

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ABSTRACT: In the medical field, we have huge volume of data which is increasingly growing, and traditional methods are not managed efficiently. The continuous challenges in biomedical computations are managing, analysis, and storage of the COVID 19 dataset. At the present time, big data technology plays a significant role in the managing and analyzing data, using deep learning techniques. Big data technologies include a Hadoop framework to process medical images. Processing medical image plays an important role to develop architectures based on big data technologies. This paper describes analytics for medical images, it shows some related work in the literature survey with a brief discussion of new approaches used in image processing, and it proposed some conclusions. Using Hadoop and Spark frameworks we adapt and extend the related work in the field of big data to provide an optimal and efficient architecture for COVID19 image analysis. Security is provided for construes the assets of the hidden message in high rate embedding from COVID 19 image dataset with encryption and decryption. The Proposed workflow with optimal methods and algorithm using Big Data for each step is projected. Hadoop framework is used to design the first architecture and spark is used to design the second architecture for image classification. To develop appropriate and efficient methods the proposed Spark architecture are used to leverage a huge number of images for classification, which can be adapted with respect to each other. Gaussian Naive Bayes classification is one of the proficient and actual supervised learning which are used to classify the numerical values. Supervisor learning is capable to take a broad assessment to give the correct results once a new data that are given as input without perceptive a priori the object.

KEYWORDS: Deep Learning, IDEA Algorithm, Gaussian, Naïve Bayes, Hadoop architecture, Spark architecture, Neural networks

I. INTRODUCTION

Big data is often defined by three major characteristics called the “5V”: Volume (Massive Volume of data), Variety (data from different categories like Structured, Semi-Structured and Unstructured), Velocity (Speed of Data Generation to provide test results), Veracity (To provide accuracy and Trustworthiness) and Value (To detect and reduce cost). Nowadays, big data problems are identified by 5V's. In medical, image dataset are too big, fast and complex to process and interpret with an existing tools. At unprecedented rates data's are generated daily from different heterogeneous sources. CT images are established within clinical settings to capture an image. With this rise of COVID 19, new demands to Artificial Intelligence (AI) for Deep learning (DL) systems to learn complex models are made. While using Deep Learning to rapidly diagnose COVID-19 on chest CT examinations is a worthwhile topic to study, unfortunately, this has been studied fairly well by various groups over the last several months. The submitted manuscript does not reference any of the published work in this area. Even a quick google search for chest CT Covid-19 Deep Learning will provide a large number of references. We have compared the performance of the proposed model with existing methods available in the literature. For comparison purposes, a set of methods [25, 26] used are logistic regression (LR), multinomial Naïve Bayes (MNB), support vector machine (SVM), decision tree (DT), bagging, AdaBoost, stochastic gradient boosting (SGB), CNN, deep transfer learning (DTL), artificial neural network (ANN), and CNN with long short term memory (LSTM).

I stephan et al. in Ref. [28] executed and surveyed the possibility of framework to arrange efficient querying of unstructured statistics in unlimited techniques. Their proposed framework is used to calculate a query in

two kind of phases. In one phase, the structured data are used to eliminate the clinical data's, while in second phase , feature extraction modules are executed on the unstructured data in a scattered manner using Hadoop architecture, thorough the query. However, their work was only limited to Hadoop, which does not include many libraries such as Deep Learning, Classification techniques, etc.

During Pandemic, the corona patients have been increased in world level, an effective model named Artificial Intelligence (AI) is an automatic prediction approach that is assumed to be a significant one towards a dense limitation of testing duration. Modeling the transmission and impact of this disease is highly significant in understanding its effect. In conventional, statistical, modeling provides better methods, AI technologies are considered a major role in identifying highly qualified detecting approaches [6]. Deep Learning (DL) method is referred to as highly important in dealing with this critical situation. DL model is a concatenation of Machine Learning (ML) approaches which is highly concentrated on the automated feature extraction as well as image classification, while it is extensively applied for object prediction operation. Here, ML and DL methods have the strategy of using AI for mining, analyzing, and determining the data patterns. Reclaiming the advancements in these applications is advantageous for making a reliable decision in the healthcare field and computer-aided systems are nontrivial since the novel data has emerged. DL is evolved from Deep Convolutional Neural Networks (DCNN) which has been applied for automated mass feature extraction, accomplished by computing convolution task. The layers proceed with nonlinear data. Every layer is composed of data conversion as lower to a higher and abstract level. Mostly, the tedious system is processed. Maximum the layers of portrayal improve data portion which is highly important for segmentation and other unwanted parameters. Typically, DL contains deep networks when compared to conventional ML ones under the application of bigdata.

II. LITERATURE SURVEY

Togacar et al. [14] projected an intelligent classification model for Pneumonia disease. Chest X-ray images are applied in this work. Here, DL models are applied and simulation outcomes are provided by applying AlexNet, VGG-16, and VGG-19 Net modules. The selected dataset has offered better accuracy. Sousa et al. [15] employed automated pneumonia diagnosis in newborns by using computer-aided models from radiographic images. Thus, pneumonia data is divided with the application of 3 classifiers. It has been examined that the applicable classifier for accessible data is SVM. Liang and Zheng [16] deployed a smart scheme to child Pneumonia disease. The CNN model has been applied to the disease. Some other COVID-19 diagnosis models available in the literature to determine the presence of COVID-19 [17-20]. In this paper, we will emphasis specifically on COVID 19 images with Big Data technologies, along with Artificial Intelligence (AI) for Deep learning. An architectural workflow describes the optimal algorithm and also reports in the literature survey. We will present a workflow performing the steps of acquisition of COVID 19 image data, analysis, storage, processing, querying, classification, and automatic diagnosis of CT images.

Literature	Dataset	Method	Accuracy Rate
CiOMPI et al. [34]	Multi centric Italian Lung Detection (MID) and Danish Lung Cancer Screening (DLCS)	Multi Scale CNN	79.5
Alakwaa et al. [33]	Lung Nodule Analysis (LUNA)	U-Net	86.6
Jin et al. [32]	Data Science Bowl and Kaggle lung CT	3D-AlexNet	87.5
Sun et al. [31]	LIDC and IDRI	DBN	81.19
Gruetzemacher and Gupta [30]	LIDC and Image Database Resource Initiative	DNN	82.10
Anthimopoulou et al. [29]	Interstitial Lung Disease (ILD)	CNN	85.61

III. METHODOLOGY

HadoopArchitecture

Based on parallel Programming, Open source Apache Hadoop Framework is used. HDFS (Hadoop Distributed File System) was developed for distributed file system which hold large amount of data which provides a easier access and also available for parallel processing. HDFS is designed to process data with sequential read and write operation. Every file is split into chunks that are stored with multiple data nodes. Map reduce program also implemented using Hadoop that is done in a lateral and scattered manner [27]. MapReduce is processed using two main function, one is Map function which transforms an element of data into key value pairs. Another is Reduce function that used to merge the values into a single result. Figure 1 proposed Hadoop Framework Architecture for MapReduce Pipeline for COVID 19 Images. Automatically classifies the image in each category from the modelling step. It will optimize the prediction and decision methods are applied to the category of images. Deep Learning algorithm is applied with each category that resulting from the classification step. Hadoop architecture is suited for processing large amount of data, other frameworks allows the achievement of real time processing and also implemented using several libraries which facilitate in programming.

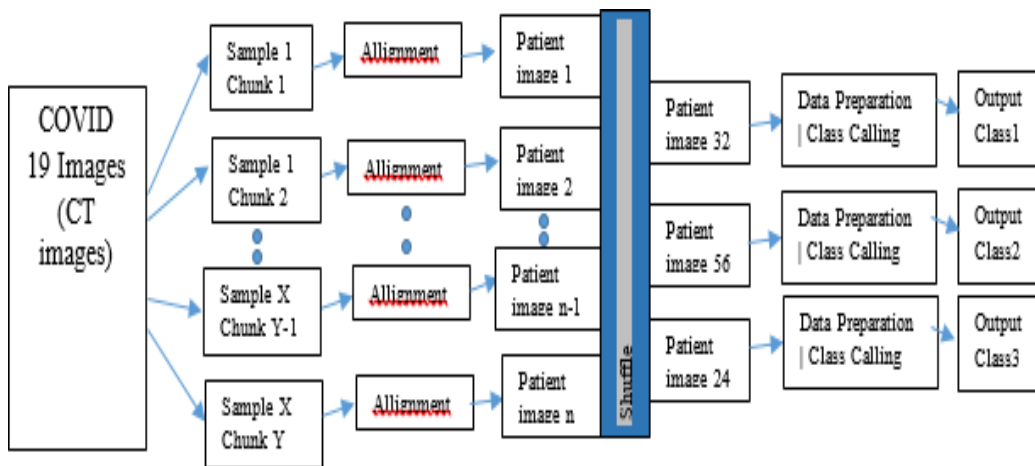


Fig1: Hadoop Framework Architecture for MapReduce Pipeline for COVID 19 Images

SparkArchitecture

Data sharing abstraction is extended in Spark architecture similar to mapreduce which is called as Resilient Distributed Datasets (RDDs).

Collection of objects in RDD's are for fault-tolerant which partitioned across a cluster that manipulates parallel. To manage the CT image dataset, complete framework are managed and are offered by Spark. It also supports queries, data streaming, Deep learning and graph processing with a Map and Reduce Operations. Performance are several times faster with capabilities of data than other data technologies. HDFS –Hadoop Distributed File System infrastructure is used to provide a functionalities that runs over a Spark. Transformations are done by users that created by RDD, to develop an architecture that enable the properties to classify the Map and Reduce Methods. Fig. 2 Spark Architecture for MapReduce Pipeline for COVID 19 Images. Spark framework are proposed to calculate the number of images in each class by ReduceByKey method, with this we count and form the image

into a matrix and also able to locate an original sample in an CT images.

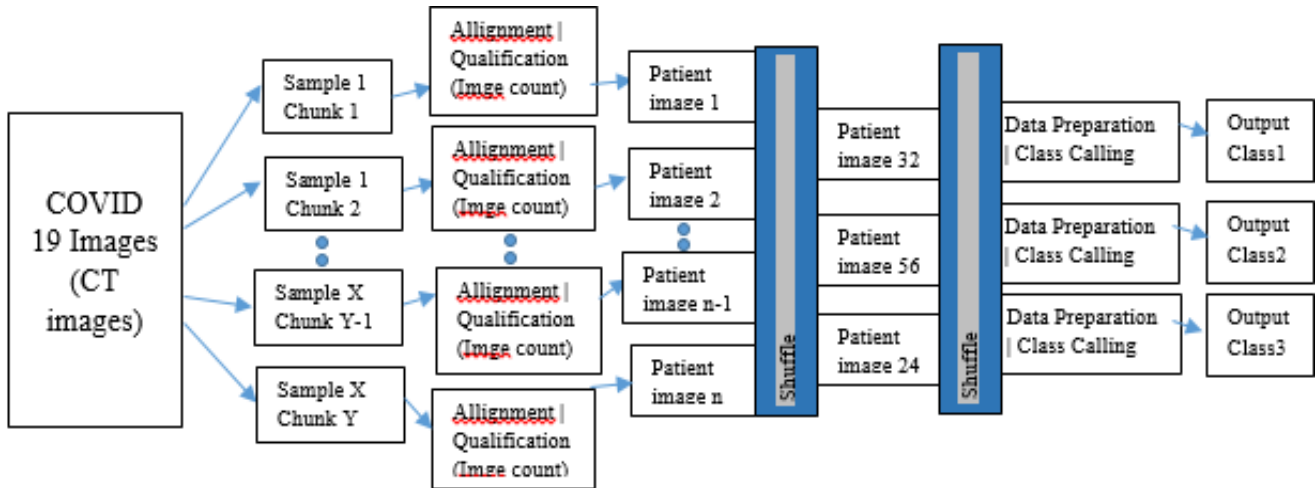


Fig 2: Spark Architecture for Map Reduce Pipeline for COVID 19 Images

1. Deeplearning

During this pandemic, new technologies give rise to new challenges in all emerging field and also in image management. Huge amount of structured and unstructured data require reliable and efficient algorithms to provide an analysis and interpretation methods to the COVID 19. Work flow based on big data are used for image analysis. Optimal methods are used to design the workflow and classify the COVID 19 images. Deep learning techniques are used to automate the analysis process and it does not allow to exchange the image of data in conventional methods. Hadoop and spark architecture allows to perform classification step that can specify the customized all step for easier implementation. For complete automation spark framework is needed. Compared to Hadoop architecture Spark architecture work together for classifying the images by two categories COVID and Non COVID. Figure 4 System Architecture using Hadoop, Spark and IDEA for COVID 19 Images workflow provides how this will structured for analysis the CT images. It will enable the remote diagnosis and telemedicine to control the supply chainsystems.

1.1. Feature Extraction using FusionModel

Here, 2 diverse feature extraction methods like VGGNet-19 as well as Inception v4 have been applied for extracting fusion of deep features from pre-processed CT images for COVID-19 prediction as well as categorization. The extracted features from these models are fused together and fed as input to the classifier.

1.1.1. CNNModel

CNN comprises a set of convolutional layers to detect patterns that exist in the image. The merit of CNN is that it finds useful in the design of a very deep network with a few parameters for training purposes. It also reduces the time and difficulty in the training task. Besides, the CNN includes different layers namely convolutional, activation, pooling, fully connected (FC) layers, and SoftMax (SM) layers. The basic concept lies in the image classification is horizontal or vertical edge recognition that is attained by executing aconvolutionoperation on the input image. CNN considers a small square (or ‘window’) known as a filter and begins to employ it over the image. Every filter enables CNN in the identification of particular patterns in theimage.

1.1.2. Convolution layer

It comprises a filter which convolves across the width and height of the input volume. Alternatively, the outcome of the convolution layer is attained by performing a dot product operation among the filter weight content and every location of the image. It leads to the generation of the 2-dimensional activation map which

offers the responses of that filter at each spatial location. Different variables that exist in the process are filter count, filter sizes, weight content, strides, and padding.

1.1.3. Pooling layer

It intends to avoid overfitting and employs non-linear down-sampling on the activation map to minimize the dimensionality and complexity to increase the processing. Several variables exist in the processes are filter size and stride, whereas padding is not used in pooling. Besides, it is employed on every input channel separately; thereby the input and output channel count become identical. The two kinds of pooling such as max pooling and average pooling are defined below.

Max pooling: The fundamental nature of this layer is identical to the convolutional layer. A major variable is that it takes maximum neighboring value from every individual location of the input image. It is carried out on every individual channel in the input.

Average pooling: In this layer, the average of every value exists adjacent to every individual location in the input image.

1.1.4. FC layers

The FC layer otherwise called hidden layer exists in the traditional neural network (NN). Prior to this process, the input array is transformed into a 1-dimensional vector by means of a flattening layer. In the FC layer, every individual node is linked to other nodes in the output layer.

1.1.5. SoftMax layer

It is employed in the output layer of the CNN for representing the categorical distribution over labels and offers the probability of the inputs to the labels.

1.2. VGGNet-16 Model

VGG-16 is one of the popular CNN approaches with 16 layers presented by Oxford Visual Geometry Group in 2014 and it has shown standard results under various image processing applications [21]. VGG16 substitute's maximum-sized convolution filters with tiny-sized filters at the time of enhancing the depth of a system. It is due to CNN with tiny filters that are highly beneficial in enhancing the classification accuracy. The expanded configuration of layers in VGG-16 is depicted in Fig. 3. The VGG-16 CNN method applied in this literature is pre-trained on ImageNet dataset and front-layers of pre-trained CNN approach are an applicable low-level universal feature that is suitable for typical image processing tasks.

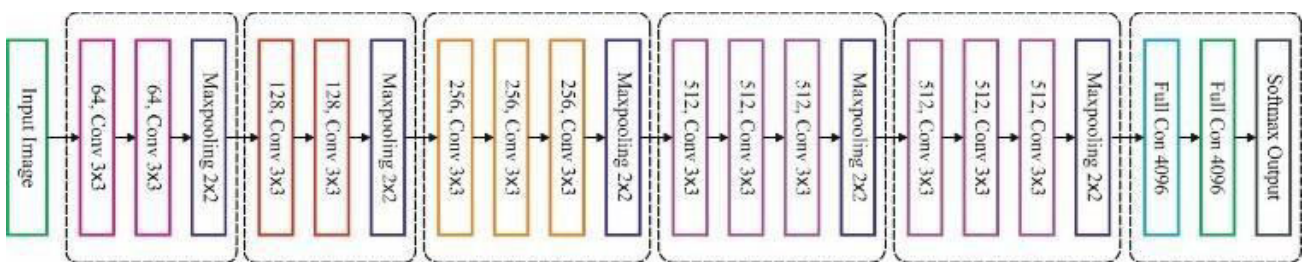


Fig. 3. VGGNet-16 model

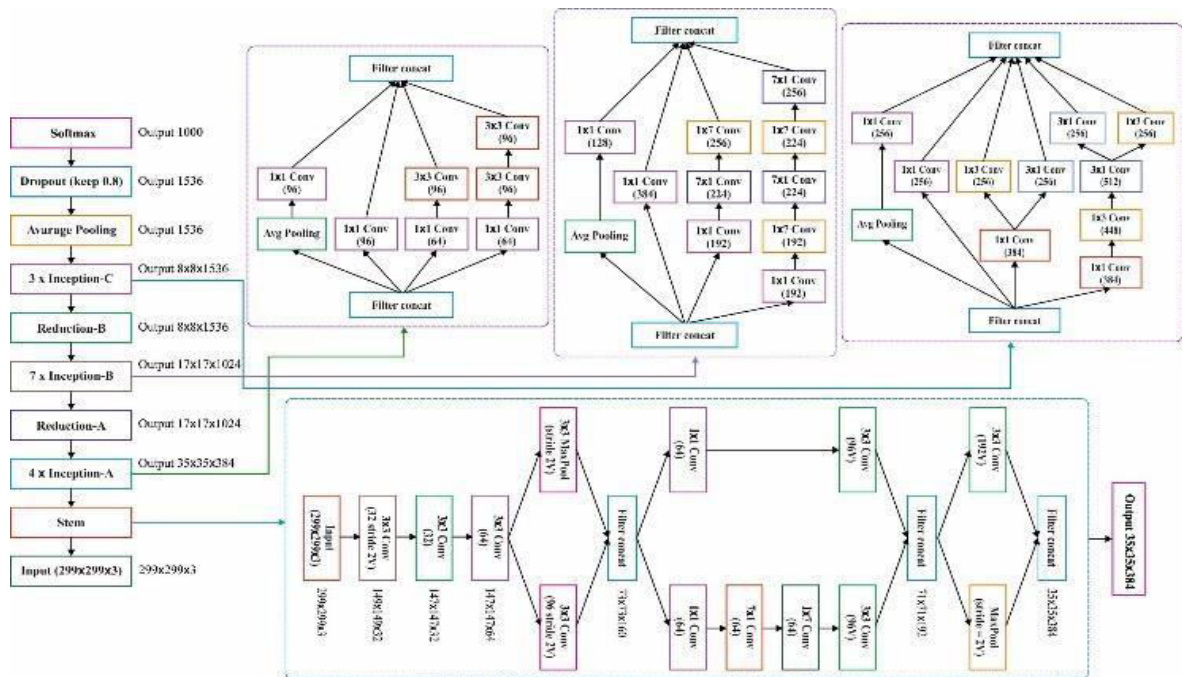
1.2.1. Inception v4 Model

The fundamental concept of Inceptions is used in diverse training parts where monotonous blocks are segregated as various sub-networks that are suitable in showing a complete model in storage space.

Hence, Inception modules are tuned easily which represents that the possibility of changing count of filters from exclusive layers which refers that it does not influence the supremacy of trained network. To improve the speed of the training process, the size of the layer has to be tuned properly to accomplish a trade-off between diverse sub-networks. Unlike other models, by using TensorFlow, the latest Inception models were



made with no duplicate segmentation. It can be caused by the function of modern memory optimization for backpropagation (BP) that has reached by activating tensors which is significant in determining gradient and estimating limited values. In addition, inception-v4 is proposed to eliminate the unwanted operation that is similar to other modules to Inception blocks in all grid sizes [22]. The entire structure of the Inception-v4 approach is showcased in Fig. 4.



Residual Inception Blocks

In this model, inception blocks were applied by the filter-expansion layer that is utilized for enhancing the dimensionality of the filter bank, before computing the depth of input. It is important while replacing the dimensionality cutback which is forced by the Inception block. It also composed of distinct types of Inception; Inception-v4 is moderate, because of the existence of numerous layers. The additional alteration among residual and non-residual. It is termed as batch-normalization (BN) that is utilized for conventional layers. Hence, the model of BN in TensorFlow consumes higher memory and it is significant to limit the overall count of layers if BN is applied in required places. Scaling of the Residuals Here, if the filter count is higher than 1000 then residual methods showcase it is instability and network is stopped at the primary stage of training that represents the destination layer prior to the pooling layer which invokes to create zeros from diverse iterations. Hence, it cannot be removed by limiting training measures. Additionally, the limited measures are appended prior to the activation layer is found and reliable in the learning process. Generally, few scaling factors are from 0.1 to 0.3 which has been applied in scaling accumulated layer activations.

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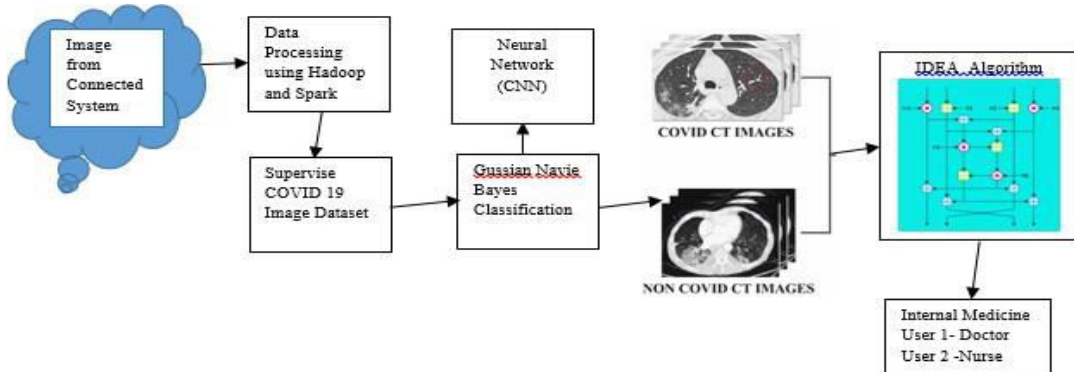


Fig 5: System Architecture using Hadoop, Spark and IDEA for COVID 19 Image

2. GNB Based Classification

Once the features are extracted from the VGG Net-16 and Inception v4 models, they are fed as input to the GNB classifier, which determines the class labels of the CT images. In NB classification, the Bayesian network with 1 root node designates the class and n leaf nodes designate the attributes. Assume C be a class label with k feasible values, and $U_1 \dots U_n$ be a group of attributes or features of the surroundings with a limited field $D(U)$ where $i=1..n$. A classification is provided with the group of the Bayesian probabilistic method with a maximum a posteriori (MAP) principle is known as discriminant function [23]. The NB classifier is determined as follows:

$$NB_{Bayes}(a) = \underset{c \in C}{\operatorname{argmax}} P(c) \prod_{i=1}^n P(u_i | c) \quad (1)$$

where $a = \{U_1 = u_1, \dots, U_n = u_n\}$ is an entire allocated set of attributes, that is, a novel instance to be classified, u_i is a short for $U_i = u_i$ and c is a short for $C = c$. An equation considers conditional independence among attributes.

A typical method to manage constant attributes in the NB classifier utilizes Gaussian distributions for signifying the possibility of the condition of the features in the classes. So, all attributes are determined by a Gaussian probability density function (PDF) as,

$$U_i \sim N(\mu, \sigma^2) \quad (2)$$

Gaussian probability density function (PDF) have the shape of a bell and is determined by the following Eq. (7):

$$N(\mu, \sigma^2)(u) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(u-\mu)^2}{2\sigma^2}} \quad (3)$$

where μ is the mean and σ^2 is the variance. In NB, the parameters required are in the arrangement of $O(nk)$, while n is the count of attributes and k is the count of classes. In particular, it is requiring determine a normal distribution $P(U_i | C) \sim N(\mu, \sigma^2)$ to all constant attributes. Parameters of these normal distributions are attained with

$$\overline{\mu_{U_i | C=c}} = \frac{1}{N_c} \sum_{i=1}^{N_c} u_i \quad (4)$$

$$\overline{\sigma_{U_i | C=c}^2} = \frac{1}{N_c} \sum_{i=1}^{N_c} u_i^2 - \overline{\mu}^2 \quad (5)$$

where N_c is the count of instances where $C = c$ and N is the count of entire instances utilized to trained. Computing $P(C = c)$ to each class is relative frequencies such that

$$P(C = c) = \frac{N_c}{N} \quad (6)$$

3. International Data Encryption Algorithm

To encrypt the bulk of data in chunks the International Data Encryption Algorithm are designed. Plain text are Fixed in size and encrypted to generate the cipher text with fixed length of key. Algorithm strength is calculated by its key length. Algorithm



- 16 bits are used for fixed length plain text
- 4 chunks of 4 bits of each are encrypted
- 16 bits cipher text are produced
- Use 32 bits length of key
- Key is also divided into 4 bits of each.

IDEA algorithm involves a complete round of series which has 4 identical and 1 half round. 14 steps are included in each complete round of series like Bitwise XOR, Addition Modulo \boxplus and Multiplication Modulo \odot . After completing 4 rounds and final half –round consists only first 4 out of 14 steps. Each binary notation must be converted to decimal notation to perform this rounds. Operation and results are converted back to the binary representation for final result.

Key schedule:

To complete each round 6 subkeys of 4 bits out of 8 subkeys are used. So 28 subkeys are used fir 4.5 rounds.

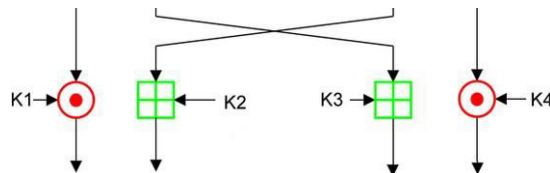


Fig 4: Operations of IDEA Algorithm with subkey

IV. CONCLUSION

Deep Learning techniques are widely used in Medical imaging filed for making support in health systems to succor COVID 19 in decision making. Data analysis methods, are able to make more accurate and efficient decisions, reduce medical errors, increase patient health, and it also reduce costs. From the studied articles, the performance of Deep Learning techniques are differs based on the characteristics of the datasets. Big data imaging was considered herein, including the methods to generate, manage, represent, and analyze imaging information for COVID 19. In this paper, we proposed a workflow for the management and analysis of COVID19 image data based on the tools of big data technology. To design our workflow, we conducted a literature review to identify the best algorithms and methods most suitable for the management and analysis of COVID 19 images. Finally we obtain the optimal architecture which we are able to give step for each. In case of Conventional systems, it does not allow to exchange the image data but it manages the CT image. To show the use of big data framework, we propose the two architecture one is Hadoop architecture and another is Spark architecture for classification step. Here we identified Spark architecture is the most complete classification step for embedding libraries for implementing the algorithm. Our proposed Spark architecture are easily adoptable in all classification steps. In future work, we should implement the spark architecture. IDEA algorithm is used to enable the remote diagnosis to protect the doctors and nurses from Coronavirus.

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