

Research Article

Deep Belief Network (DBN) Approach for Classification of COVID-19 Impact on People with Diabetes

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Abstract

The World Health Organization (WHO) has announced the COVID-19 flare-up to be a general health crisis of global concern. In serious cases, COVID-19 can cause infection in the lungs (pneumonia), causes kidney malfunction and even demise. Individuals, under all ages will be contaminated by this harmful virus. Major cases of COVID-19 affected patients are normal with negligible influenza like no side effects. Some have gentle indications, more like a typical infection due to SARS-CoV-2 and has prompted severe sickness. Most of individuals who have come down with the infection have not should have been hospitalized for strong consideration. Elder people and people with previous ailments (like diabetes, coronary illness and asthma) give off an impression of being more unprotected against getting seriously sick with the COVID-19 infection. Specifically when people with diabetes adopted with a viral disease, it is essential to treat with more attention and high care because of changes in blood glucose levels and, perhaps, the presence of diabetes complexities. The proposed DBN based methodology characterizes the effect of COVID 19 over diabetic patients with most regular indications of COVID-19 and wellbeing factors identified with diabetes. The model gets 98.86 % of accuracy during training and 97.81 % of accuracy during validation.

Key Words: *COVID-19, Deep Belief Network, Classification, Diabetes, Performance*

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Introduction

Presently India turned into the third nation to record 300,000 COVID-19 deaths in the midst of developing trepidation about the conceivably deadly contagious disease striking a few patients who have struggled by the infection. So it is significant for everybody to know about the most prevailing manifestations of COVID-19 to have the option to distinguish them, take appropriate treatment and keep safe from complexities [R1].

The COVID-19 pandemic has been around for over a year now. People contaminated with the novel Covid illness have shown a wide scope of manifestations, from mild and moderate, to serious or critical. With the infection is changing its structure quickly and with new variations being found, more current and surprising appearances are being seen in as of late contaminated patients. As per the American Diabetes Association, individuals with diabetes are bound to get contaminated with COVID-19; in any case, those with diabetes have more awful results, like higher paces of genuine complexities [R2].

Factors Influencing Covid-19 Patient's Severity of Illness

Coronavirus is a sickness brought by the Covid SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2), known as a profoundly infectious illness, presently influencing in excess of 200 nations around the world. The primary component of SARS-CoV-2 that recognizes it from other infections is the speed of transmission joined with higher danger of mortality from Acute Respiratory Distress Syndrome (ARDS). Individuals with Diabetes Mellitus (DM), serious stoutness, cardiovascular illness, and hypertension are bound to get contaminated and are at a higher danger of mortality from COVID-19. Among old patients who are at higher danger of death from COVID-19, 26.8% have DM. Albeit the explanations behind this expanded danger are yet to be resolved, a few variables may add to Type-2 DM patients' expanded to severe diseases[R3-R4].

A potential factor that may assume a part in expanding the danger in individuals influenced by diabetes and additionally stoutness is the disabled inborn and versatile safe reaction, portrayed by a condition of persistent and poor quality irritation that can prompt sudden fundamental metabolic change. SARS patients recently determined to have diabetes or hyperglycemia had higher

mortality and horribleness rates when contrasted and patients who were under metabolic control. Essentially, fat people are at higher danger of creating complexities from SARS-CoV-2. In this audit, we will investigate the current and advancing bits of knowledge appropriate to the metabolic effect of Covid-19 diseases with exceptional regard for the primary pathways and systems that are connected to the pathophysiology and treatment of diabetes[R5].

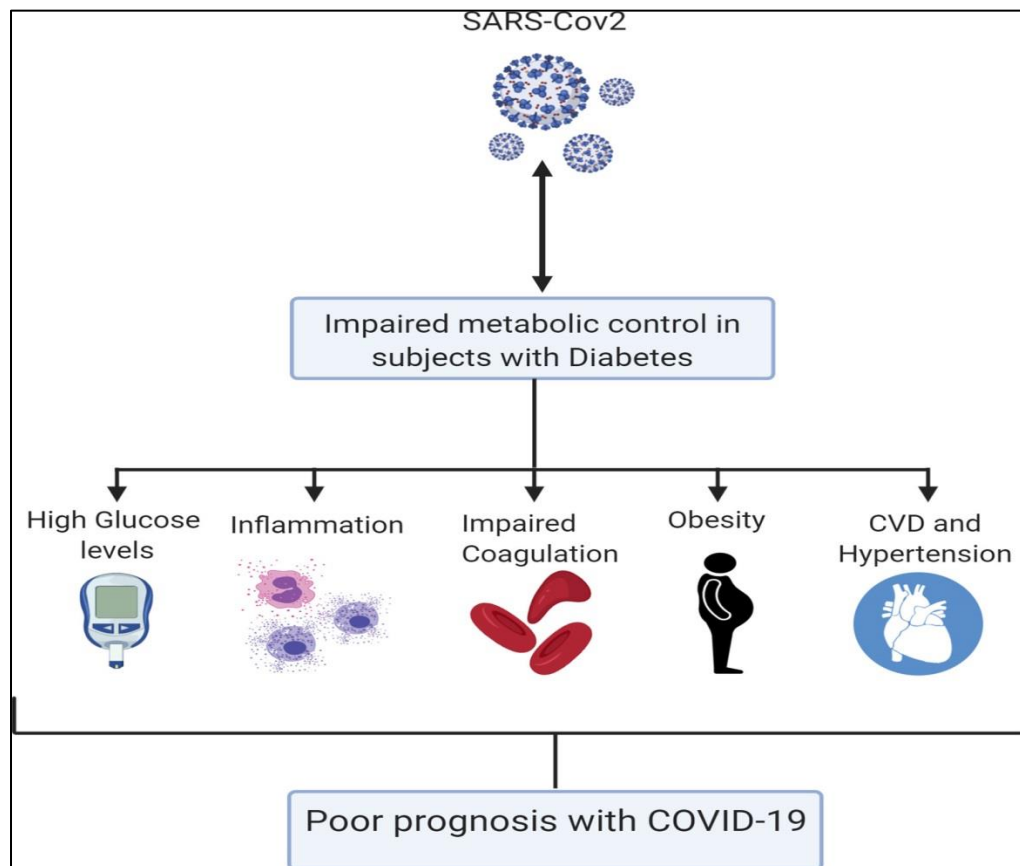


Figure 1 : Various factors by which Diabetes can impact on COVID-19 poor outcome[R5]

People with Diabetes Mellitus (DM), severe obesity, CVD, and hypertension are at a higher risk of poor outcome from COVID-19 . The reasons underlying this increased risk have not been determined. However, a panoply of factors may contribute to Type-2 DM(T2DM) patient increased risk of poor outcomes of COVID-19 disease as shown in Figure 1. Individuals affected by diabetes and/or obesity generally have an impaired innate and adaptive immune response, characterized by a state of chronic low-grade inflammation which can lead to abrupt systemic metabolic alteration, characterized by higher levels of leptin (a proinflammatory adipokine) and lower adiponectin (an anti-inflammatory adipokine) . An unfavorable hormone environment also

contributes to dysregulation of the immune response [7]. Typically, obese people have defective innate immunity manifested by enhanced production of several proinflammatory cytokines.

Symptoms of the Covid-19 Second Wave Infection

India is currently undergoing the second wave of COVID-19 and the infection is supposed to be more irresistible than it was beforehand. Individuals with COVID-19 have had a wide scope of manifestations revealed going from gentle side effects to serious sickness. Indications may seem 2-14 days after openness to the infection. Anybody can have gentle to extreme manifestations[8]. Individuals with these manifestations may have COVID-19:Fever or chills Cough, Shortness of breath or trouble breathing, fatigue, muscle or body aches, headache., new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, diarrhea. shortness of breath or trouble in breathing, is one of the early indications of Covid, dominantly seen in infected patients during the second wave of COVID-19. Although the power of shortness of breath can differ among people, this indicator leaves most patients with a sensation of snugness of the chest, bringing about the steady gasping of air, every time.

Studies propose that breathing troubles are generally found in the second rush of COVID-19 patients, directly at the beginning of the disease. The disease causes abatement in oxygen immersion (SpO2 levels) which may bring about lung harm and in few cases, even different organ failure. Other than this, other more indications or symptoms of the second wave of COVID-19 disease, that we should know about include:Basically Gastrointestinal (GI) plot involves the principle organs of acclimatization, including the mouth, food pipe, stomach/gut, little and digestive organ. Any unsettling influences in the GI structure can reduce the immunity. Indications of GI structure diseases related with COVID-19 incorporate loss of craving, heaving, stomach torment, and free stools. Hearing trouble is another one of the indications in the second arrival of COVID-19 disease. It might go from mild, moderate to serious which brings about an unexpected hearing trouble, debilitated hearing, or ringing sound in your ears (tinnitus). This beginnings right off the bat in the main seven day stretch of disease and resolves throughout some undefined time frame. Dangerous weakness and laziness have been accounted for as one of the early manifestations of the COVID-19 disease[9-10].

Once our body recognizes the COVID-19 infection as a trespasser, it starts the safe reaction to battle the infection, and this can bring about the contaminated individual inclination drained and

frail. Similarly Pink eye disease of the eye which brings about the expanding of the external straightforward film (called the conjunctiva) of your eyelid and eyeball. Dry mouth or insufficient salivation is caused when adequate spit isn't created by the concerned organs (salivary organs), it prompts a condition called dry mouth, which can prompt tooth and gum sicknesses and make you helpless to diseases. Dry mouth is presently a typical and beginning indication of COVID-19. Diarrhea or free watery stools is one of the far and wide manifestations seen in COVID-19 patients during the subsequent wave.

Reports propose most people influenced with COVID-19 griped of diarrhoea for 1 to 14 days, with a normal span of 5 days. Also sudden cerebral pains can be a side effect of COVID-19. A typical migraine that proceeds for quite a while and doesn't die down with pain killers, is being accounted for as one of the more current side effects seen during the second COVID-19 wave. Recent examinations have featured skin rashes as another symptoms of COVID-19. Patients have detailed rashes on all fours, which are normally called acral rashes.

Studies recommend that these rashes can create because of the immunological reaction to the infection. The COVID-19 infection is majorly transient through tainted drops perceptible all around when somebody snuffles, talks or hacks. Also, people pick the infection from polluted surfaces and afterward contact our eyes, nose, or mouth, expanding the likelihood of contaminations of the eye, alongside the nose and mouth[11].

Complications of Diabetes and Its Suit-Up by Covid-19

Diabetes and its intricacies, for example, diabetic neuropathy, diabetic nephropathy, diabetic cardio vascular diseases, diabetic retinopathy and amputation have been perceived worldwide as a significant general health risks. Foreseeing diabetic difficulties in connection with Covid-19 is the need of the day which can assists with expanding the exceptionally successful endurance pace of diabetic patients. While numerous examinations right now utilize clinical pictures and organized clinical records, extremely restricted endeavors have been devoted to applying information scientific strategies for unstructured printed clinical records, for example, confirmation and release records. In addition, early expectation of entanglements will assist the specialist with cautioning the patients and to take choice on their treatment way. The proposed Deep conviction Network based Covid-1p effect forecast framework for diabetic patients will

arranges and predicts potential confusions level of diabetic patients, for example, Covid-19 Normal impact, Covid-19 Moderate effect and Covid-19 Severe effect.

Diabetes and Covid -19

Diabetes is one of the main sources of illness and mortality all through the world. The condition is related with a few macrovascular and microvascular difficulties, that eventually sway the general patient's endurance [12]. A connection among diabetes and contamination has for some time been clinically perceived. Diseases, especially flu and pneumonia, are regularly normal and more genuine in more seasoned individuals with type 2 diabetes mellitus (T2DM) [13-15]. Nevertheless, the proof remaining parts dubious in regards to whether diabetes itself to be sure expands vulnerability and effects results from diseases, or the cardiovascular and renal comorbidities that are habitually connected with diabetes are the principle factors included. Diabetes and uncontrolled glycaemia were accounted for as huge indicators of seriousness and passings in patients tainted with various infections, including the 2009 pandemic flu A (H1N1) [16], SARS-CoV and MERS-CoV . In the flow SARS-CoV-2 pandemic, a few examinations didn't track down a reasonable relationship among diabetes and serious infection [17-18].

Scant information exist in regards to blood glucose management and improvement of intense complications of diabetes (e.g., ketoacidosis) in patients with COVID-19. Contamination of Corona virus in those with diabetes potentially triggers higher pressure conditions, with more noteworthy arrival of hyperglycemic chemicals, e.g., glucocorticoids and catecholamines, prompting expanded blood glucose levels and unusual glucose inconstancy [19].

It was partially recognized that diabetes has been related with more dreadful results in COVID-19 affected patients, the defenselessness to SARS-CoV-2 contamination may not be higher in individuals with diabetes. As indicated by a few examinations, the predominance of diabetes in individuals contaminated with the infection is about equivalent to in everybody, even marginally lower [20-21]. A meta-examination of 12 investigations depicting information from 2,108 Chinese patients with COVID-19 announced a diabetes commonness of 10.3% , which was like the public pervasiveness of 10.9% revealed in 2013[22].

Methodology

There is not enough data to show whether people with diabetes are more likely to get COVID-19 than the general population. The health complications among people with diabetes face

is they're more likely to have worse complications if they get it, not greater chance of getting the virus. Also, the more health conditions someone has (for example, diabetes plus heart disease), adds to their risk of getting those serious complications from COVID-19. Based on the CDC report, people with type 1 or gestational diabetes might be at an increased risk for severe illness from COVID-19. The risk of getting very sick from COVID-19 is likely to be lower if the diabetes is well-managed. Having heart disease or other complications in addition to diabetes could worsen the chance of getting seriously ill from COVID-19, like other viral infections, because more than one condition makes it harder for our body to fight the infection.

Data Set Description

The dataset have been gathered from an open-source information repository GitHub and different other CDC reports. The recently collected dataset contains around 879 patients information is put away which have shown manifestations of Covid and other infections. Information comprises of around 25 credits to be specific p_id, p_name, sex, age ,address, wellness, intubated, supplemental O2 level, extubated, Body temperature, pO2_saturation, BGL(1->200 mg/dL (11.1 mmol/L)/0-<200 mg/dL (11.1 mmol/L),period of diabetes, Body Mass Index (weight in kg/(stature in m) ^2), ABS level (Average Blood Sugar in mg/dl),Hemoglobin A1C(%),Blood Pressure, leukocyte_count, lymphocyte check, neutrophil tally, difficulties, methodology, date of contamination distinguished, side effects, drug, class variable (0 or 1), 0 for Covid-19 - negative and 1 for Covid-19 positive. Out of these accessible 879 datasets,80 % is considered for training and 20% is considered for validating.

Deep Belief Network (DBN) for Covid-19 Impact level Classification

Figure 2 shows the structure of the proposed Covid-19 confusion level forecast over diabetic patients utilizing DBN. The DBN comprises of two divergent kinds of NNs: Belief Networks and RBM. The dataset utilized for the proposed work is Diabetic Repository. First the dataset goes through pre-processing by utilizing RBM. Pre-processing is performed to improve the performance of the proposed framework.

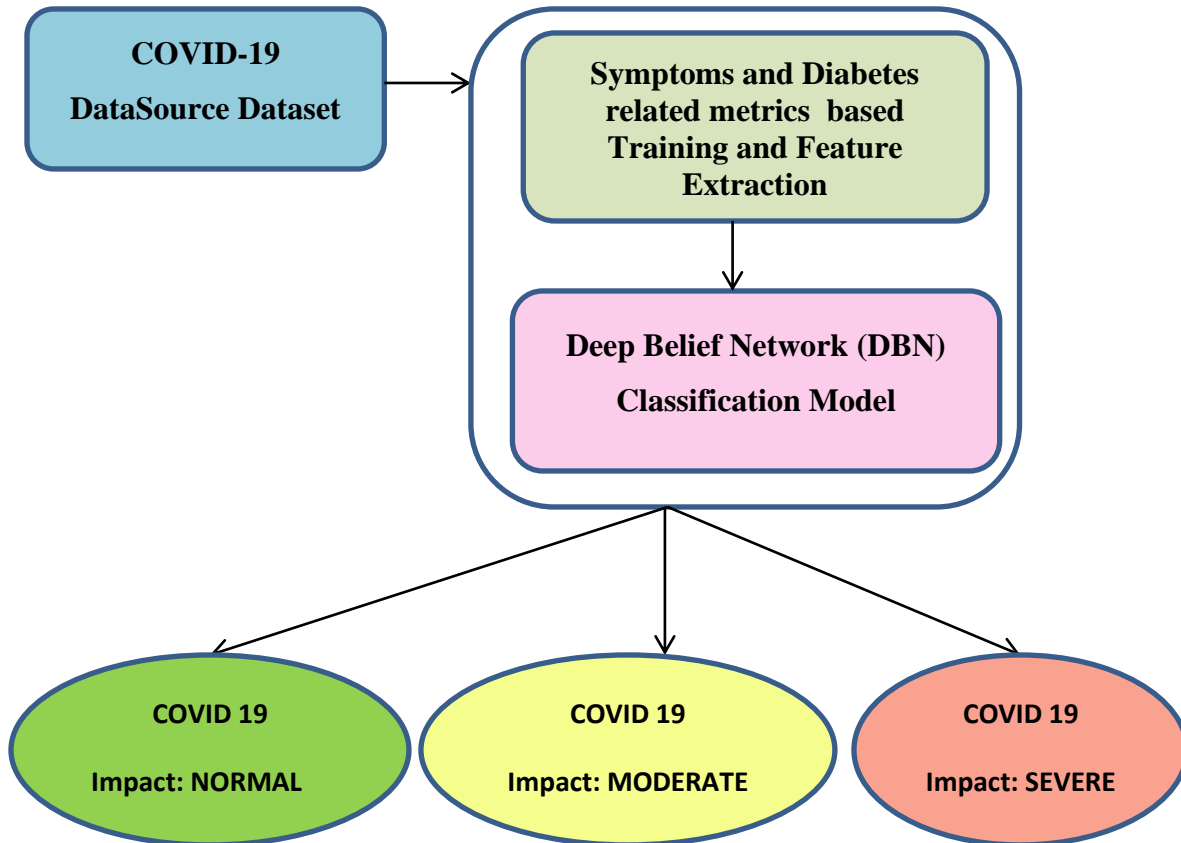


Figure 2: DBN Based Model for Covid-19 Impact Analysis on Diabetic Patients

Feature extraction process is performed followed by training. Then DBN centered final classification is handled. Then, centered on the validation process, a Covid-19 impact level on diabetic people related is predicted effectively based on various factors related to diabetes such as ABS level (Average Blood Sugar in mg/dl),HbA1C(Hemoglobin A1C(%)),period of diabetes, Body Mass Index (weight in kg/ (height in m) ^2), Blood Pressure, pO₂ saturation and other related attributes etc. Based on the threshold level of each factor the harshness of Covid-19 is metered as normal, moderate and severe.

Results and Discussion

The Covid-19 affected patients in the dataset are classified based on complications level related to diabetes. The analysis on complication returns three different categories. Also the performance of DBN is analyzed based on basic metrics as discussed below.

Complication Analysis

The proposed DBN based classification model classifies the diabetic patients affected by Covid-19 under three level of health conditions as shown in Figure 3.

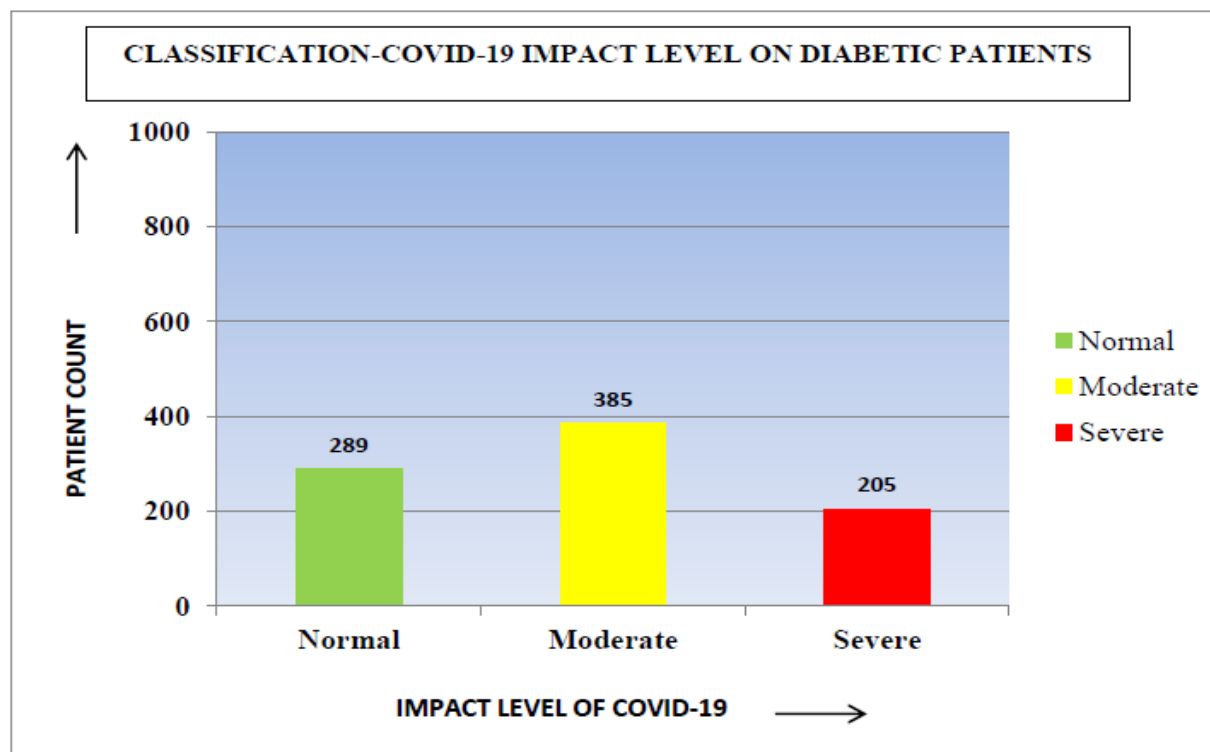


Figure 3: Classification of Covid-19 Impact Level on Diabetic patients

The first category conveys the count of Covid-19 patients' normal in health without any specific boosted inflammation and complications due to diabetes. These patients are the one who have controlled diabetes and followed regular medication. The model predicts, there are 289 patients who are under the category of normal impact.

The second category, counts 385 patients with diabetes and the inflammation level of moderate. They are the patients having frequent variation in their blood glucose and HbA1C threshold levels. The final category of impact shows that there are 205 patients who are under severe complications of Covid-19 due to their uncontrolled diabetic factors.

Performance Analysis

The performance of proposed DBN model is measured in terms of accuracy, precision, recall and F1-measure based on TP (True Positive),TN(True Negative), FP(False Positive), FN (False Negative) values of classification result obtained.In the proposed model TP is the range of Covid-19 patients correctly predicted as severely infected ,TN is the collection of patients belongs to normal category or in the range of moderate category and have been predicted as it is. Similarly FP count shows the patients who were predicted as under severe impact but originally they are normal. Finally FN of the current implementation denotes the head count of patients predicted as normal, but naturally they are affected moderately or severely. The performance is assessed as follows and represented as shown in Figure 4.

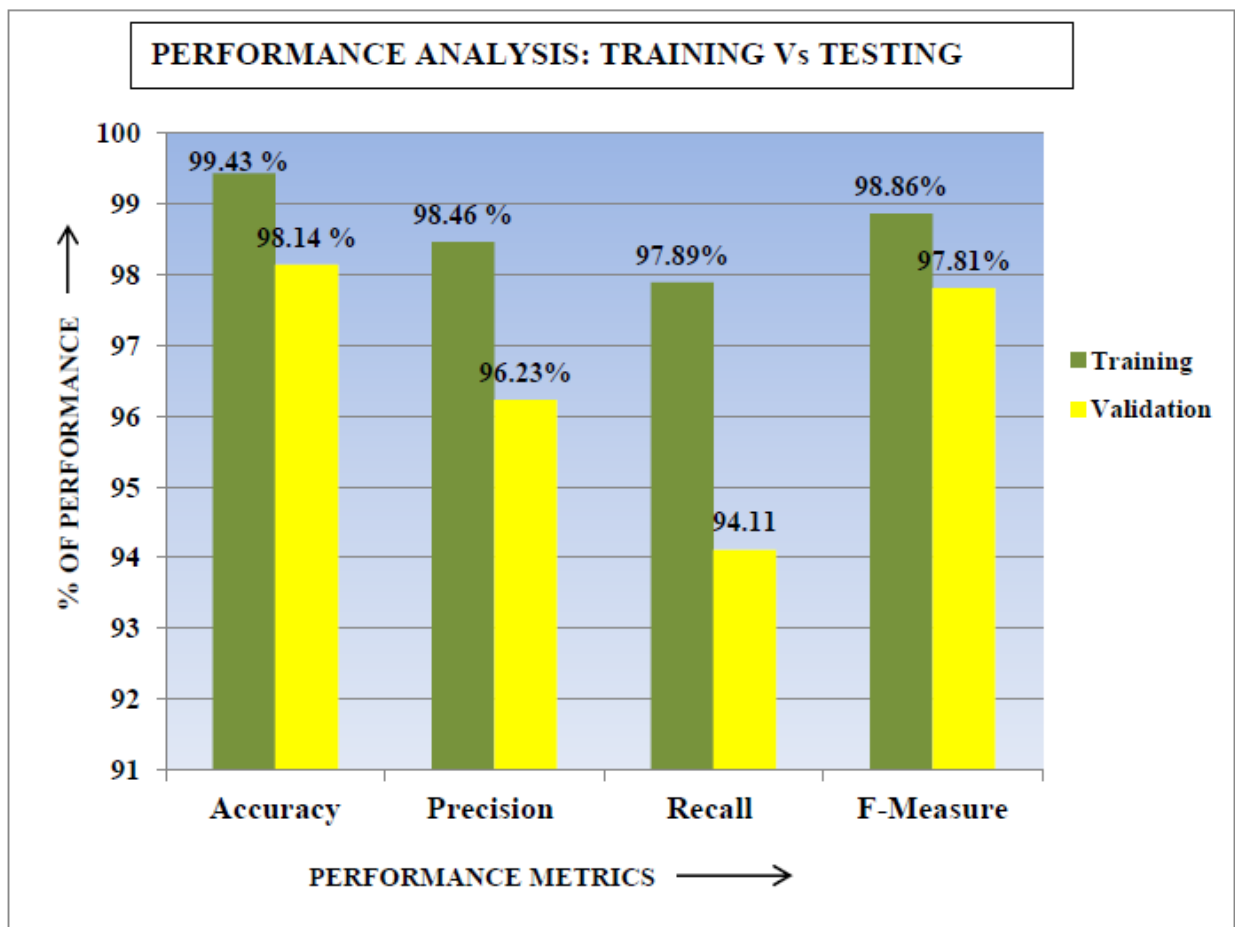


Figure 4: Performance Analysis: Training and Testing

The metrics are measured as follows:

Accuracy (ACC): It is defined as the systematic errors which measure the statistical biases caused between true and predicted value.

$$\text{Accuracy} = \frac{TP + TN}{P + N}$$

Precision (P): Precision is calculated as out of all the positive classes how many classes are predicted correctly as actually positive.

$$\text{Precision} = \frac{TP}{TP + FP}$$

Recall (R): Out of all positive classes, how much classes are predicted correctly. It should be high as much as possible.

$$\text{Recall} = \frac{TP}{TP + FN}$$

F1-Measure: F1 score is the measure of test accuracy calculated from precision and recall.

$$\text{F1 - Measure} = \frac{2TP}{(2TP + FP + FN)}$$

The performance during training and validation process were compared.

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