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**EXAMINING A PATIENT WITH A STETHOSCOPE
USING AN ARDUINO DEVICE**

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Master's Thesis

Supervisor

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EXAMINING A PATIENT WITH A STETHOSCOPE USING AN ARDUINO DEVICE

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DEDICATION

I dedicate my dissertation work to my family and many friends. I would like to dedicate to my supervisor Asst. Prof. Dr. Abdullahi Abdu IBRAHIM which help me in all stages of the thesis.

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ABSTRACT

EXAMINING A PATIENT WITH A STETHOSCOPE USING AN ARDUINO DEVICE

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The stethoscope is an audio medical expedient for auscultation, or hearing to interior sounds of an physical or human body. Arduino is a physical programming platform consisting of an I / O (I / O) board and development environment that includes an implementation of the Processing / Wiring language. LSTM is an artificial recurrent neural network (RNN) architecture used in the field of deep learning. Unlike standard feed forward neural networks, LSTM has feedback links. It can process not only single data points (such as images) but also entire data strings (such as speech or video).

In this study, new method presented for heart diseases detection by combining deep learning techniques based on optimization algorithm. In the first stage, LSTM applied to classify the heart signals that are obtained by Arduino. The BBO applied to enhance the performance of the LSTM by applied to reduce the error rate of the LSTM model. The presented method presented satisfactory results when compared with previous studies.

Keywords: Stethoscope, Arduino, LSTM, BBO

ÖZET

ARDUINO CİHAZI KULLANARAK STETOSKOP İLE BİR HASTANIN İNCELENMESİ

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Stetoskop, oskültasyon için veya bir fiziksel veya insan vücudunun iç seslerini duymak için sesli tıbbi bir çözümdür. Arduino, bir I / O (I / O) panosu ve İşleme / Kablolama dilinin bir uygulamasını içeren geliştirme ortamından oluşan fiziksel bir programlama platformudur. LSTM, derin öğrenme alanında kullanılan yapay bir tekrarlayan sinir ağı (RNN) mimarisidir. Standart ileri beslemeli sinir ağlarının aksine, LSTM'nin geri bildirim bağlantıları vardır. Yalnızca tek veri noktalarını (görüntüler gibi) değil, aynı zamanda tüm veri dizilerini (konuşma veya video gibi) işleyebilir.

Bu çalışmada, optimizasyon algoritmasına dayalı derin öğrenme tekniklerini birleştirerek kalp hastalıklarının tespiti için yeni bir yöntem sunulmuştur. İlk aşamada LSTM, Arduino tarafından elde edilen kalp sinyallerini sınıflandırmak için uygulandı. BBO, LSTM modelinin hata oranını azaltmak için uygulanarak LSTM'nin performansını artırmak için başvurdu. Sunulan yöntem, önceki çalışmalarla karşılaştırıldığında tatmin edici sonuçlar verdi.

Anahtar Kelimeler: Stethoscope, Arduino, LSTM, BBO

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LIST OF ABBREVIATIONS

SVM	:	Support vector machine
KNN	:	K-nearest neighbours algorithm
NN	:	Neural Network
RBF	:	Radial Basis Function
CNN	:	Convolutional Neural Network
DT	:	Decision Tree

1. INTRODUCTION

Auscultation has played a very important role in diagnosis in the medical field for many years. First In the Hippocrates period (460-370 BC), the patient's abdomen and chest area It was applied with direct contact and was named as direct auscultation. 1816 French Doctor René Théophile Hyacinthe Laënnec's direct auscultation in uncomfortable with his technique and a paper rolled between the patient's body and his ear The stethoscope was invented by putting it on [1], [2]. Then the stethoscope over the years It has taken its present form by making many improvements.

Since its invention, its use has increased rapidly and is used by almost every physician. The classical stethoscope has some disadvantages. For example, the stethoscope Depending on the area of placement, some sounds may become weaker or different. At the same time, the stethoscope measures the frequency components of the audio signal above 112 Hz. has a attenuating frequency response [3]. With the amplification of low frequencies this Although heart sounds in the frequency range can be heard, human The ear is quite weak at hearing sounds with low frequency components [4]. All this deficiencies display or recording of sound signals received from the human body It gave birth to the need. "Electronic Stethoscope" has been invented in response to this need.

Electronic stethoscopes convert acoustic sound waves into electrical sound signals transmits sound to listeners over a cable. Electronic stethoscope tone microphone by taking them through pre-upgrade, filtering and upgrading processes respectively it transmits the electrical signal to the speaker or screen and can also record.

The signals from the HS sensor of an electronic stethoscope are recorded directly from the patient by an electronic stethoscope. Some commonly used transducers in a stethoscope are microphones, piezoelectric transducers, etc. Sound signals from the heart are converted into analog electrical signals.

Comparison of electronic and analog stethoscopes shows that the digital approach to auscultation is actually superior to its predecessors, refuting the idea that electronic models can suffer from mute and contact artifacts that reduce their usefulness.

Thus, the low frequency range that the human ear cannot hear can be displayed. However, with the adjustable height and filter range, in the classical stethoscope the problem of high frequency audio components weakening is also eliminated. The rapid increase seen in studies on electronic stethoscopes in recent years, this It also shows the importance of the devices.

On the other hand, Arduino, an I / O board and an implementation of the processing / wiring language from the development environment, open source by Italian electronics engineers developed and anyone who wants to download their own circuits ready-to-print and components with an elegant appearance if they wish. flexible, easy-to-use hardware and software-based physical programming platform [5]. Arduino team Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino and David It consists of Mellis. Nicholas Zambetti has contributed from the beginning [6].

Arduino can be used to develop stand-alone interactive objects as well as It can also be connected to software running on the computer. Sell ready made cards Information on hardware design for purchasers or for those who want to produce it themselves available. The microprocessor (AtmegaXX) on the Arduino development board is programmed with the Arduino programming language, and this program is Arduino Software based on Processing. It is installed on the board with the help of the Development Environment (IDE).

1.1 RESEARCH QUESTIONS

In this study, after investigating the field and previous studies several questions are occurred which that will answer in this study. The answering of these researches lead to great contributions in the field of educational data mining. What is electronic stethoscopes and why becomes very important topic in the last years? What are the electronic stethoscopes with Arduino presented and what are the weaknesses of these studies? What are the techniques can reduce the cost of stethoscopes to remove? The aim of this step is reduce the computation time which means gain in the cost and hardware.

1.2 MOTIVATION OF THE STUDY

An electronic stethoscope is used without an ear canal. Increase the distance to the patient without losing sound quality. It is very effective and suitable for infectious patients. The electronic stethoscope does not need to be connected to a power source when it is working.



2. OVERVIEW

2.1 AI IN HEALTHCARE

The use of artificial intelligence in medicine is no longer a legend. Now, the biggest assistant of doctors in every field, algorithms, machine learning systems and skillful robots ... Artificial intelligence is revolutionizing health as in every aspect of our lives. Healthcare services around the world are also significantly affected by this change. Machine learning and AI are impacting doctors, hospitals and all other health-related areas. According to Eric Topol's article published in the journal Nature Medicine, in the future, everyone in the health sector, from specialist doctors to first aid workers, will use artificial intelligence technology. According to the data of GE, the artificial intelligence market for the health sector will exceed 6.5 billion dollars by 2021. Considering that 39 percent of decision makers in the healthcare sector plan to invest in machine learning and predictive analysis systems, this number will increase in the coming years [7].

2.1.1 Diagnosis of Diseases

Correct detection of diseases requires years of medical training. Even after this training, making a diagnosis is a difficult and time-consuming task. In many areas of medicine, the demand for experts has exceeded the supply, which stresses doctors and the diagnosis of diseases is further delayed. Machine learning - especially deep learning - algorithms have recently made great progress in automatic diagnosis of diseases, making the diagnostic process cheaper, easier and more accessible. Machine learning algorithms learn to see certain patterns in the same way as doctors do. The only difference is that algorithms need a large number of instances to learn and need to be digitized meticulously. Unfortunately, machines cannot open and read textbooks yet. Machine learning is useful in the following similar areas where the diagnostic information that doctors examine is digitized: Diagnose lung cancer and stroke by analyzing computed tomography scans. Determining the risk of sudden heart attack by analyzing electrocardiograms. Classification of lesions by analyzing skin images. Determination of diabetic retinopathy indicators by analyzing eye images. Thanks to the abundance of data in these areas, algorithms can be at least as successful in diagnosis as expert doctors. The only difference is that algorithms can be diagnosed in a very short time and can be done inexpensively from anywhere in the world. In a short time, it is aimed that people all over the world will receive the same quality service in radiology diagnosis for a

very low fee. Radiology is one of the areas where artificial intelligence attracts the greatest attention. More than two billion chest X-rays are taken every year around the world. According to research, artificial intelligence algorithms are more successful than humans in evaluating these x-rays and diagnosing diseases. These algorithms are used in all kinds of medical imaging systems such as CT, MRI, echocardiogram and mammography as well as x-rays, and results are obtained at speeds up to 150 times compared to humans. Some of the benefits of artificial intelligence in radiology are expected to be: Detecting breast, lung or prostate cancer: To help diagnose central nervous system tumors. To distinguish benign from malignant lesions. Calculating the volume and size of brain tissues on MR images and analyzing functional MR images.

The use of machine learning in diagnostics is still in its infancy. Systems will soon begin to emerge that improve the quality of diagnosis by bringing together different data sources - IT data, MR data, genome and proteomic data, patient files, and even handwritten files.

However, it should not be inferred from all of these that artificial intelligence will replace doctors.

According to a 2016 study, doctors spend more time on data entry and desk work than on patients. In case of automation in processes such as data entry and analysis of test results, artificial intelligence systems will warn and inform about potential problems, enabling doctors to pay more attention to patients and interpret signals more effectively. Considering that the world population is getting older and the need for a doctor is gradually increasing, every second saved can save and prolong the lives of many people. Moreover, artificial intelligence will not only save time for doctors, it will also reveal a lot of information that will open new horizons. According to studies, a hospital generates 50 petabytes of data each year - enough to fill 20 million four-drawer filing cabinets. However, 97 percent of this data is not used at all. Artificial intelligence algorithms also have the potential to reveal new methods of diagnosis and treatment by compiling and analyzing this wasted data. The question of artificial intelligence or doctors is also among the topics that are frequently raised on the popular side of the business. For example, contest programs that confront artificial intelligence systems and doctors are very popular on Chinese TV. In one of these programs, a team of 25 specialists competes with an artificial intelligence system called Biomind for the diagnosis of brain tumors, and the machine is now 2-0 ahead against humans. Artificial intelligence makes it easier to diagnose people not only about their physical condition, but also

about their mental state. Machine learning systems help experts in diagnosing psychological problems by analyzing people's digital data, interactions, tone of voice, and facial expressions [8].

2.1.2 Artificial Intelligence Assisted Surgeries

Artificial intelligence systems can guide surgeons during the operation by analyzing the patient's data before surgery. The systems can also combine data on past surgeries to develop new and more effective surgical techniques. According to researches, complications are reduced by five times in artificial intelligence-assisted operations and hospital stay is shortened by 21 percent. One place where artificial intelligence will save human lives will be emergency services. In emergency services where a race against time is taking place, dozens of images, the medical history of the patient and many other elements must be examined in order to correctly diagnose a person who has had a traffic accident and to apply an effective treatment. Artificial intelligence and deep learning algorithms can guide doctors by compiling and analyzing this data much faster than humans [9].

2.1.3 Drug Development

Developing drugs is a very expensive process. The majority of analytical processes during drug development can be handled much more effectively by machine learning. This will shorten the work that can take years, and reduce the investment of millions of dollars.

Artificial intelligence is used successfully in all four main stages of the drug development process:

- a- Determining the targets to be intervened
- b- Determination of possible drug candidates
- c- Accelerating clinical trials
- d- Finding biomarkers for diagnosing the disease.

2.1.4 Personalized Treatment

Different patients react differently to drugs and treatments. Hence, personalized treatment is critical in extending the life expectancy of patients. However, it is not easy to determine the factors

used to determine which treatment method should be chosen. As Doctor Bertalan Meskó, who describes artificial intelligence as "the stethoscope of the 21st century", stated in his article, artificial intelligence can suggest personalized treatments, therapies and medicines by burying the "uniform" treatment in history. Machine learning can automate this complex statistical work and enable the identification of indicators that can be used to determine the patient's response to a particular treatment. The system learns this by cross-evaluating similar patients, comparing the treatments applied to the patients and their results. The resulting insights can make it easier for doctors to determine what treatment to take. For example, colon cancer patients in Brazil do not want to undergo surgery due to their culture. That's why doctors turn to methods such as radiotherapy and chemotherapy. However, only 20 percent of the patients react positively to these methods. So, how will it be determined which patient is included in this 20 percent group? This is where deep learning algorithms come into play. Algorithms scan the data of patients and determine the appropriate treatment method in a short time and accurately [10].

2.1.5 Gene Editing Skills

CRISPR, especially the CRISPR-Cas9 system, has provided great convenience in editing DNAs faster, cheaper and with higher accuracy. This technique is based on targeting and arranging the guide RNA to a specific region in DNA. However, the guide RNA may also be directed to a different area from the targeted area in the DNA, which may cause undesirable side effects. Machine learning models have proven successful in predicting the side effects that may arise from both guide-target interactions and guide RNA's orientation to a different target. This can greatly speed up the development of guide RNAs for all regions of human DNA. Of course, the main goal of these systems is to facilitate the work of doctors and to increase the quality of healthcare services. The aim should be to simplify, organize and in this way increase the quality of service. Systems that will distract doctors with extra clicks, comprehensive training, and flashing lights can make things more difficult. That's why it is very important to work with experts in AI solutions. GE is one of the most reliable and experienced business partners in this field. GE's artificial intelligence systems are used successfully in many hospitals. For example, smart systems and solution packages established by GE at Massachusetts State Hospital open new horizons for the diagnosis and treatment of neurological diseases and stroke. According to the data, every 40 seconds in the United States suffers a stroke. The combined treatment and medicine costs and lost

workforce resulting from this put a burden of \$ 34 billion on the US economy. GE's imaging systems and artificial intelligence applications that interpret the data obtained from them both save lives by providing early detection and intervention, and allow billions of dollars in savings. Vanderbilt University Medical Center also uses GE's artificial intelligence systems in cancer diagnosis and treatment. GE's systems analyze demographic data, genome data, and imaging systems data to reveal the most appropriate treatment method for current and future patients. GE's Edison Platform integrates all data from different sources, interprets it using advanced analysis systems and artificial intelligence systems, and produces usable, concrete data. In this way, performance and efficiency increase, decision processes are accelerated. Many applications are being developed running on this platform. AIRx, which automates the workflow of MR images, Critical Care Suite, and CT Smart Subscription, which automatically updates computed tomography software, are just a few of them [11].

2.2 ARDUINO

Arduino is open source hardware with Atmel microcontrollers. In addition to software information, design information is also available to the user. PCB printed circuits, circuit diagrams, layout plans and the codes of the programmable elements on it are opened in a way that the user can easily reach the user with all their details. The user can either take it ready-made or do the same himself. The microcontroller (AtmegaXX) on the Arduino development board is programmed with the Arduino programming language and this program is uploaded to the card with the help of the Processing-based Arduino Software Development Environment (IDE). The Software Development Environment (IDE) can be downloaded for free on the internet. The basic C language is used for programming. The most important feature that brings Arduino to the foreground is that its software is easy and simple. It also allows the user not to deal with other peripherals (crystal, power supply, programming device) to implement the application. The reason it doesn't need a programming device; The product comes with the bootloader program thrown into the microcontroller. One of the most powerful features of Arduino is that it has an extensible library system. Thanks to these libraries, many operations and communication between peripherals can be performed easily. In addition, libraries written for new peripherals can be easily integrated. Considering all these, it is possible to realize many applications using Arduino without being a very advanced software developer. There are many types of Arduino according to the feature of

the project to be realized. In addition, additional equipment that provides ease of use called shield (layer) designed in accordance with these cards are also offered to the manufacturer's service. (Bluetooth, Wireless, Ethernet, Motor driver layers etc.) [12].

2.2.1 Arduino Usage Advantages

-Arduino with USB port connection as it has a bootloader can load programs to the microprocessor. In this way, microprocessors can be removed and The risk of leg fractures caused by snagging is eliminated. Arduino programming is easier than other programming. It is cheaper compared to other platforms. It provides an easy software environment thanks to its simple and open programming environment.

2.2.2 Arduino Uno

Arduino is an open source physical programming platform that performs basic input and output applications with peripheral elements using the Processing / Wiring language. Interactive applications can be realized independently with Arduino. At the same time, by communicating Arduino with the computer via many software such as Flash, Processing, MaxMSP, C Sharp or with software you have written yourself

You can use. [13] Arduino UNO R3 is the latest model of Arduino Uno. It supports all the features found in previous models (Uno, Duemilanove). With the UNO R3 model, the 16U2 model was used instead of the 8U2 model in the previous versions. In this way, faster data transfer has been achieved using less memory. No driver is needed to connect Arduino to the computer on Linux and Mac computers. On Windows computers, it is sufficient to introduce the inf file that comes in the Arduino IDE software to your computer. In this way, you can connect your Arduino to your computer such as keyboard, mouse, joystick and similar accessories. you can make it available. UNO R3 has extra SDA and SCL pins, these pins are located next to the AREF pin in the card layout. However, on the card from previous versions differently, two new pins have been added next to the reset pin. One is the IOREF pin to supply the shields over the board and the other is the empty disconnected pin reserved for future use. UNO R3 is compatible with all shields on the market and with its new pins, it is also compatible with new shields that will be produced from now on. There are various Arduino boards within the Arduino family, depending on the project,

usage and demand. These; Arduino Uno, Arduino Mega 2560, Arduino Pro, Arduino Leonardo, Arduino Fio, Arduino Mega ADK, Arduino Nano etc. These cards are of different performance, features, processors and capabilities. On the Arduino Uno R3 board, there are 8-bit Atmega328 processor, 14 digital input-output pins, 6 of them can be used as PWM outputs, there are also 6 analog input pins. In addition, 16 Mhz crystal oscillator, USB connection, regulated 5V, ICSP header and reset button are available. It provides the power required for operation from the PC via USB connection or from a 7-12 Volt DC power supply. Lower and upper limits for the supply voltage are determined as 6-20 V. Current per input / output pin is 40 mA. There is also a regulated 3.3 V output on the board and the output current for 3.3 V is 50 mA. FLASH Memory 32KB, SRAM Memory sizes are also specified as 2 KB, EEPROM 1 KB. Also; When using an external power supply, input can be made from the VIN pin on the Arduino board.

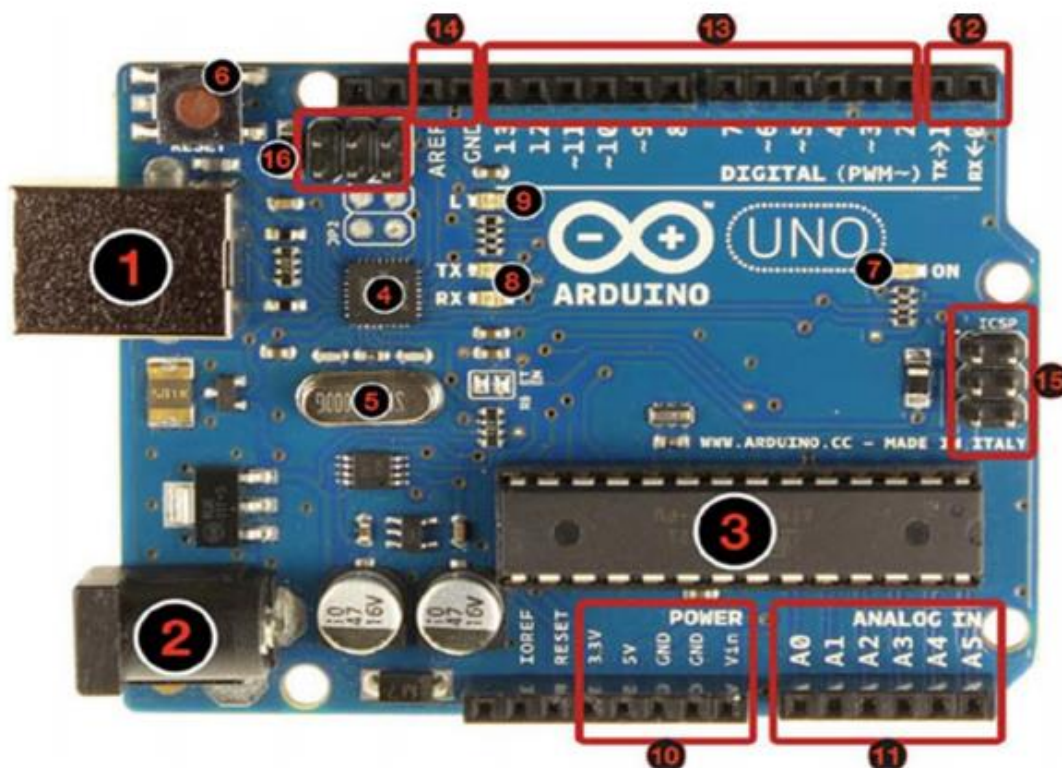


Figure 2.1: Arduino Uno

2.3 TECHNIQUES AND METHODS

In the following sections, we'll provide shortcuts and data processing methods to define features composed from smartphone devices and conclude behavior vicissitudes Persons in actual lifetime doings. These approaches can be labelled as a series of dispensation Ladders, which start from initial sensory data and lead to predict the well-being of users as they infer their behavior vicissitudes. In Figure 2.2, we have shown the humblest instance of data flow from left to right is to provide recognition of human behavior the system.

In the next subsets, it define shared of respectively phase of the procedure preliminary with: Understanding uncooked device data and removing topographies calm from smartphone sensors pertinent. Moreover, the classification methods discussed (for instance, normal Supervised learning approaches, semi-supervised learning approaches, un supervised learning approaches.

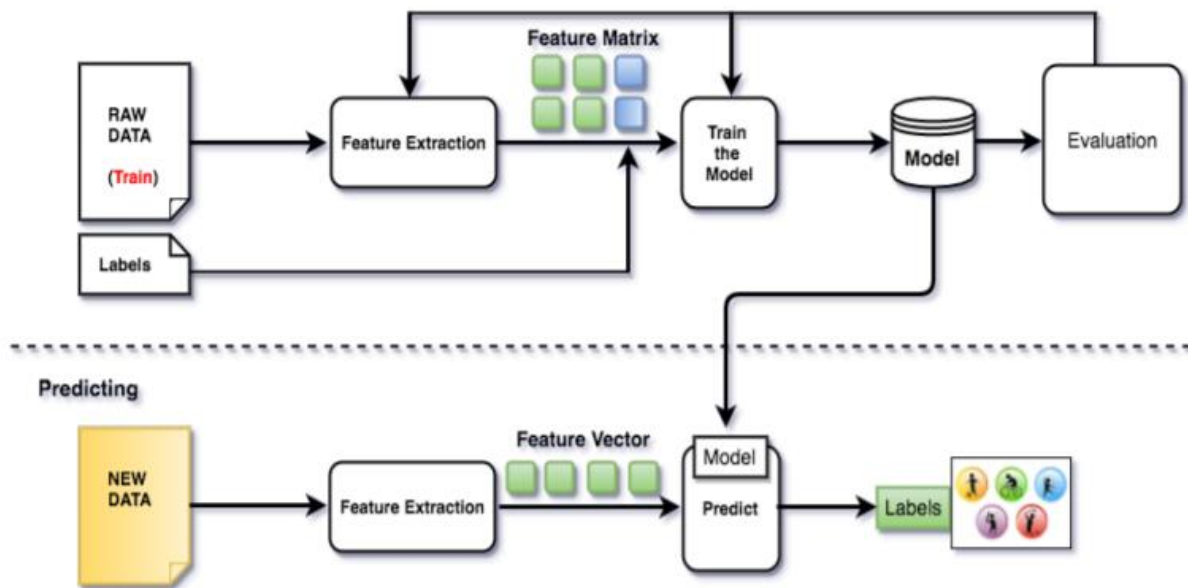


Figure 2.2: Machine learning for Monitoring [4]

2.3.1 Interpreting raw sensor data

As shown in Figure 2.3, the primary phase of feeding the identification scheme is feature group. At this point, the measured data needs conversion to a pre-numeric format the behavior form bus is group for other training phases. Furthermore, raw device feature Composed or captured from built-in sensors (for example, an accelerometer, a gyroscope, Magnetism) is empty deprived of its interpretation, like human interpretation Behavior or additional connected features. As such, a diversity of data mining methods and arithmetic measurement tools are often applied to understand info from the feature calm by smartphone, for instance, total activity level, daily steps, and total user-managed distance As well as cluster with their collection of networks of persons execution in the neighborhood [14].

2.3.2 Normalization

Normalization is a method that is often practical as portion of data groundwork for data mining. The goalmouth of standardization is to alteration the standards of numeric pillars in the dataset to an overall scale, deprived of misrepresenting the changes in the worth varieties. For ML, not each data groups require normalization. Required only when it has features for different ranges [15].

2.3.3 Feature Extraction

Feature extraction is a procedure of dimensionality decrease by which an early group of raw feature is abridged to additional wieldy collections for treating. A typical of these big data groups is a big amount of variables that need a huge of calculating capitals to process. Feature extraction is the term for approaches that choice and /or syndicate variables into features, efficiently dropping the quantity of feature that necessity be treated, though still precisely and totally telling the unique data set.

Extracting features is beneficial when you require reducing the amount of capitals wanted for dispensation deprived of behind significant or pertinent information. Extracting features can also decrease the quantity of extra features for a specific analysis. Reducing data and machine efforts in building variable sets facilitates learning and mainstreaming in machine learning [16].

Results can be improved using built-in sets of application-based features, typically built by an expert. One such process is called the geometry feature. Instead, general dimension reduction techniques such as: Independent component analysis, Autoencoder, Principal Component Analysis, Edge detection, Corner detection, Blob detection, Ridge detection.

2.3.4 Heart Disease

Coronary heart disease affects the coronary arteries that supply the heart muscle with oxygenated blood. CHD includes arteriosclerotic plaques within the coronary arteries, which leads to narrowing of the artery. The blood flow to the heart is connected by the left and right coronary arteries, which supply blood on the opposite side of the heart. Each coronary artery branches into additional arteries, which are responsible for providing oxygenated blood to a specific area of the heart tissue. Stenosis and decreased blood flow through one of these arterial parts can have adverse effects on the heart muscle and lead to myocardial infarction (MI).

The risk factors for coronary artery disease have been divided into persistence. Non-customizable hazard issues contain: age, gender, and private antiquity that cannot be changed. Rendering to the American Heart Association, adjustable hazard issues that can be regulated through health and existence interferences are: high blood pressure, hypercholesterolemia, physical idleness, diabetes, weight gain, fatness, and tobacco smoke. He said that changes in adjustable risk factors make up about 60% of the risk reduction.

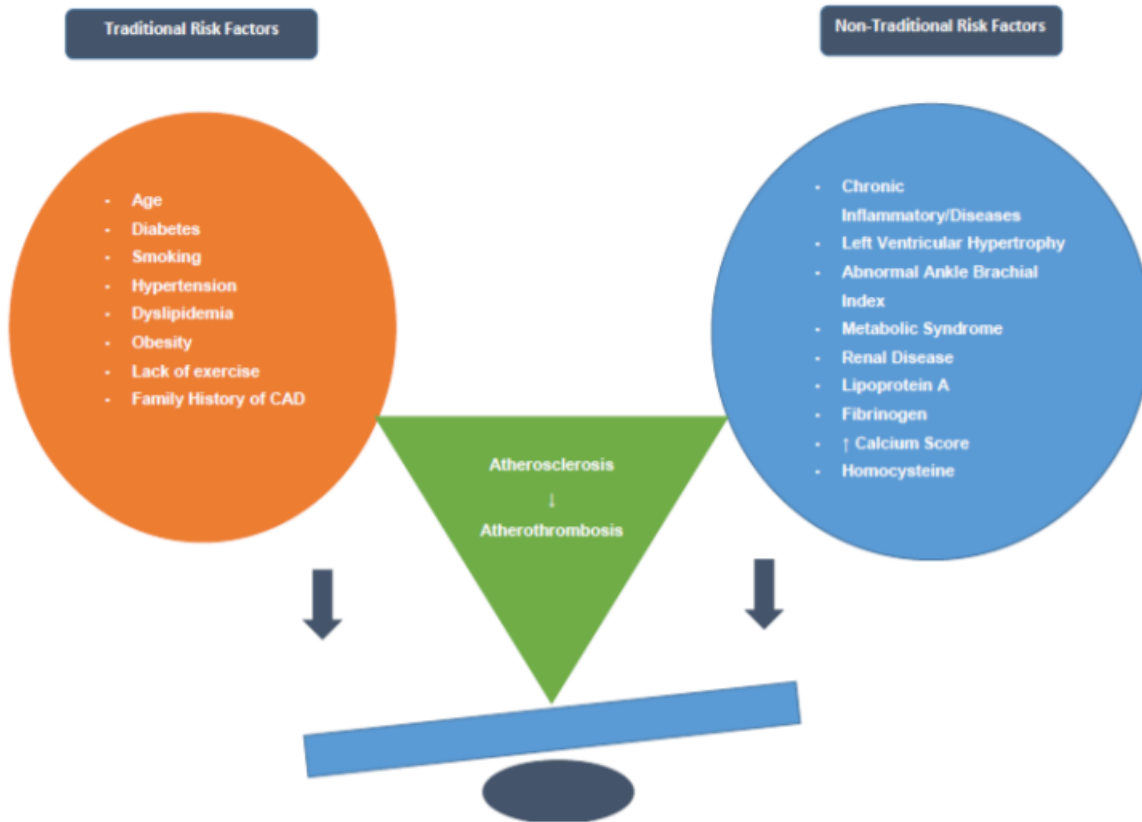


Figure 2.1: Cardiovascular disease (CVD)

Cardiovascular disease (CVD) was the main killer Americans for decades. In the past years, a heart bout or hit nearly surely caused in decease. But progress In biomedical research, enhanced spare reply Systems, treatment and prevention efforts He helped the Americans fight. Between 2000 and 2011, The researchers found deaths related to the national heart The rate dropped at a rate of 3.7 percent annually, while Stroke deaths decreased by 4.5 percent annually.

Medical analysis theatres energetic part and yet complex job that wants to be performed professionally and precisely. To decrease price for attaining clinical tests a suitable computer depend data and decision support must be assisted. Data mining is the apply of software methods for discovery designs and constancy in groups of data. Also, with the arrival of information mining in the last two decades, there is a large chance to let computers to straight concept and categorize the dissimilar qualities or lessons. Learning of the danger mechanisms connected with heart sickness aids curative facilities experts to identify patients at high danger of having Heart disease. Statistical analysis has recognized risk issues related with heart sickness to be age, blood pressure,

entire cholesterol, diabetes, overexcited tension, family past of heart illness, fatness and lack of bodily exercise, abstaining blood sugar etc. Tobacco use, corrupt, and bodily diet Idleness increases the danger of emotion attack and hits. High blood pressure has no indications; though it can reason a unexpected hit or heart attack. Diabetes upsurges the danger of heart bout and hit. Weight gain increases heart risk attacks and hits. Little socioeconomic rank upsurges. Opportunities for contact to danger issues and Upsurges susceptibility to the development of cardiovascular diseases.



Figure 2.2: Heart Test [17]

Coronary artery disease is caused mainly by atherosclerosis and its development is linked to conservation and hereditary issues. Atherosclerosis is a chronic procedure branded by a gradual buildup of fat, rubbery rudiments and provocative particles in the walls of big veins. Arteriosclerosis begins with the flow of low-density lipoprotein (LDL) fat into the interplanetary under the lining, which can be adjusted and corroded by several factors. Corroded / modified LDL particles are strong chemical molecules that stimulate appearance of vascular bond and intercellular bond particles on the superficial of the endothelium and rouse adhesion and single

cell migration in the space under the endothelium. The subunits become macrophage in the intimate medium. Macrophage establishes oxidized LDLs through scavenger receptors to develop froth lockups and release professional inflammatory cytokines, containing interleukins and polyp necrosis issue.



3. MATERIAL AND METHODS

3.1 MACHINE LEARNING (ML)

Machine learning (ML) is a class of algorithm that lets software applications to develop extra exact in forecasting consequences without being openly automatic. The rudimentary evidence of machine learning is to shape procedures that can obtain input facts and apply arithmetical analysis to forecast an production while informing productions as new information develops available. The procedures complicated in machine learning are alike to that of data mining and prognostic modelling. Together need searching finished information to appearance for designs and adjusting package movements therefore. Numerous persons are acquainted with ML from spending on the internet and existence helped ads connected to their acquisition. This occurs because reference trains use ML to initial online ad distribution in nearly real time. Outside modified advertising, additional shared machine learning apply suitcases contain deception recognition, spam filtering, network security threat recognition, prognostic upkeep and construction news feeds [18]. Unsupervised algorithms do not want to be skilled with wanted product information. In its place, they apply an iterative method named deep learning to appraisal information and reach at deductions. Unsupervised learning algorithms -- also named neural networks -- are applied for extra multifaceted dispensation errands than supervised learning structures, counting image credit, speech-to-text and natural language group. These neural networks effort by searching finished millions of instances of training data and mechanically classifying often understated associations among numerous variables. When trained, the algorithm can apply its bank of relations to know new information. These systems have only developed possible in the stage of big information, as they need huge quantities of training data. With all the enthusiasm and publicity about AI that's "just around the corner"—self-driving cars, immediate machine conversion, etc.—it can be problematic to get how AI is moving the exists of even persons from instant to instant. What are instances of AI that you're previously applying—right now? In the procedure of circumnavigating to these arguments on your shade, you nearly surely applied AI. You've also probable applied AI on your method to effort, interactive online with networks, penetrating on the web, and creation online purchases. We differentiate among AI and ML through this object when suitable. At Emerj, we've industrialized real meanings of both AI and machine learning founded on a board of expert response. To abridge the conversation, reason of AI as the wider goal of independent machine

intelligence, and machine learning as the exact technical approaches presently in fashion for structure AI. All ML is AI, but not all AI is ML. Our counted instances of AI are separated into Work & School and Home applications, however there's sufficiently of area for overlay. Each instance is escorted with a "glimpse into the upcoming" that exemplifies how AI will continue to convert our everyday exists in the close upcoming [19].

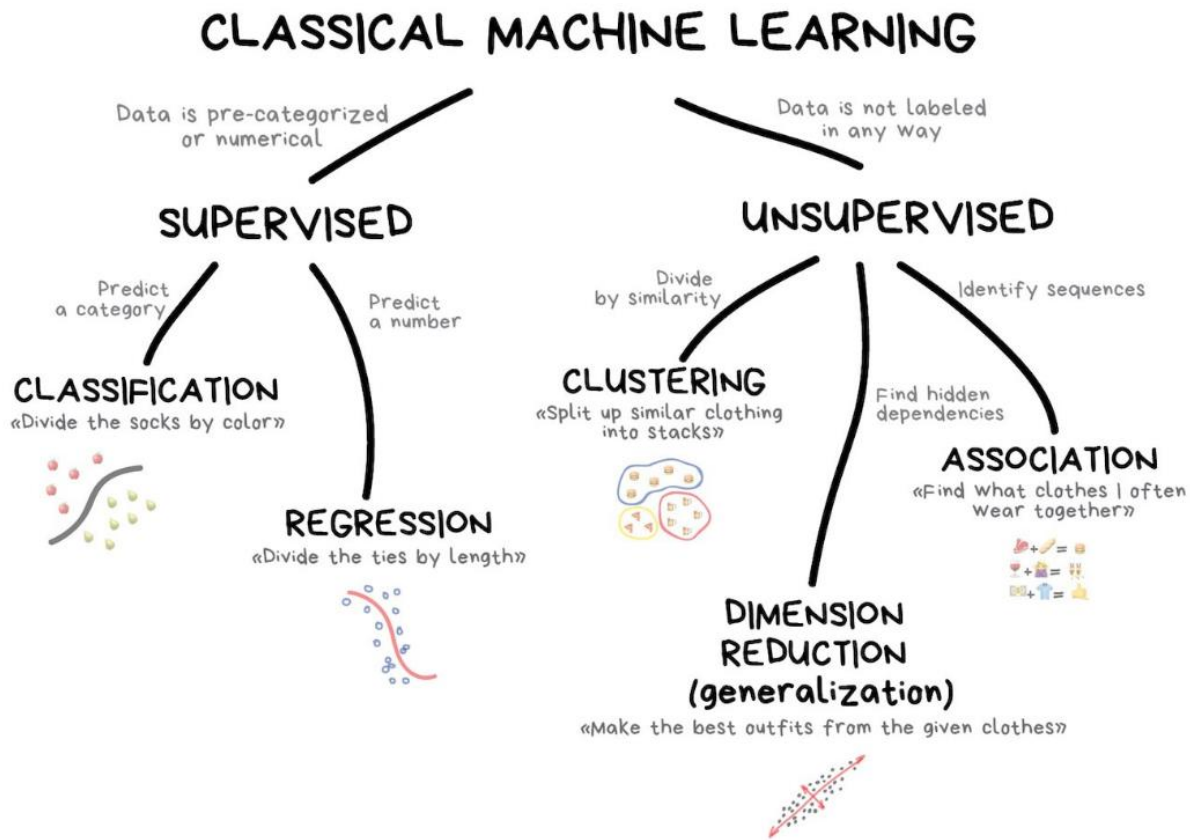


Figure 3.1: Machine Learning Techniques [20]

3.1.1 Unsupervised learning

Unsupervised was conceived a bit advanced, in the '90s. It is applied fewer frequently, but occasionally we just have no excellent. Labelled facts are treating. Nonetheless what if I poverty to make, let's approximately, a automobile classifier? Must I manually take photos of zillion fucking automobiles on the roads and label apiece of them? No method, that will income a generation, and I motionless have so numerous games not frolicked on my Vapour explanation. There's a slight confidence for entrepreneurship in this circumstance. Thanks to communal stratification, we have lots of inexpensive labours and facilities such as Motorized Turk who are

prepared to whole your job for \$0.05. Then that's how belongings typically become complete here [21]. Or you container stab to apply unsupervised learning. Nonetheless I can't recall any good applied application for it, however. It's typically beneficial for investigative data study but not as the chief system. Particularly trained meat bag with Oxford grade foods the mechanism through a ton of trash and timepieces it. Are there any groups? No. Any noticeable relatives? No. Healthy, endure formerly. You required to effort in data science, right?

3.1.2 Clustering

Clustering is the job of separating the populace or data opinions into a amount of collections like that data opinions in the similar collections are more similar to other data points in the same group and dissimilar to the data points in additional collections. It is essentially a group of substances on the foundation of resemblance and difference among them. For example, the data opinions in the graph underneath clustered composed can be categorized into one lone cluster. We can separate the clusters, and we can classify that there are 3 clusters in the underneath picture.

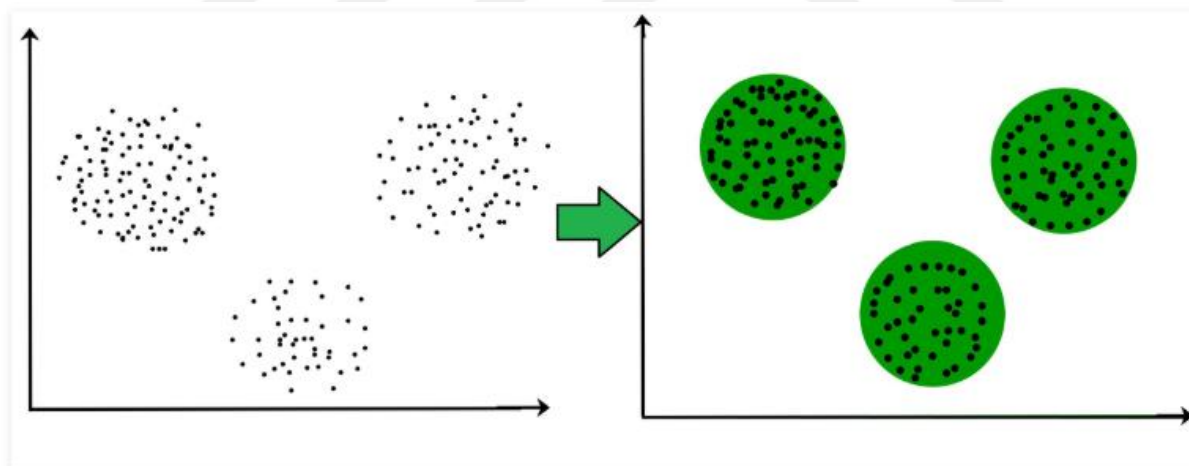


Figure 3.2: Clustering [22]

It is not essential for clusters to be a sphere-shaped like figure 2.5. These data opinions are clustered by applying the simple idea that the data opinion deceits inside the assumed restraint from the cluster center. Numerous distance approaches and methods are applied for control of the outliers. Clustering Methods are listed below:

3.1.2.1 Density-Based Methods

Density based clustering algorithm has frolicked a energetic role in discovery non-linear forms construction depend on the density. Density-Based Spatial Clustering of Presentations with Racket (DBSCAN) is greatest extensively applied density based algorithm. It applies the idea of density reachability and density connectivity.

3.1.2.2 Hierarchical Based Methods

Hierarchical clustering includes generating clusters that have a prearranged collation from highest to lowest. For instance, all records and files on the hard disk are prepared in a hierarchy. Figure 2.5 represented the hierarchical clustering.

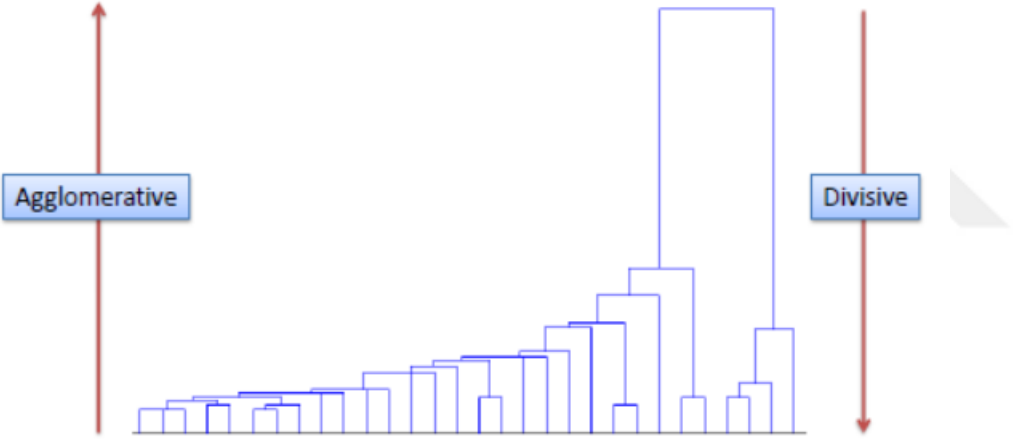


Figure 3.3: Hierarchical Clustering [23]

3.1.2.3 Partitioning Methods

The humblest and most important form of cluster analysis is dividing, which systematizes the substances of a conventional into numerous high-class sets or clusters. To save the problem requirement brief, we can assume that the amount of clusters is assumed as related information. This limit is the preliminary opinion for separating approaches. Officially, assumed a information set, D , of n substances, and k , the amount of bunches to form, a dividing algorithm systematizes

the substances into k dividers ($k \leq n$), where each divider signifies a cluster. The clusters are shaped to enhance an impartial partitioning standard, like a difference function depend on distance, so that the substances inside a group are “similar” to one extra [24].

3.1.2 Supervised learning

Supervised learning, in the situation of AI and ML, is a kind of organization in which mutually input and wanted output data are delivered. Input and output data are labelled for classification to deliver a knowledge foundation for upcoming data dispensation. The period supervised learning originates from the impression that a procedure is learning from a training dataset, which can be supposed of as the educator. Supervised machine learning organizations deliver the learning procedures with recognized amounts to provision future rulings. Chatbots, self-driving cars, facial recognition packages, expert systems and robots are between the schemes that may apply moreover supervised or unsupervised learning. Supervised learning models are typically related with retrieval-based AI but they may also be accomplished of applying a propagative learning system [25]. For example, supposing assumed a bag occupied with dissimilar types of ovaries. Nowadays the primary stage is to train the engine with altogether dissimilar ovaries one by one similar this:



Figure 3.1 : fruits

- A. If form of item is round and unhappiness at upper needing color Red formerly it will be branded as –Apple.

B. If form of item is extended bent tube needing color Green-Yellow then its determination be labelled as –Banana.

Today supposing afterward training the feature, you have assumed a new distinct fruitlet say Banana from bag and requested to classify it.

Meanwhile the machine has previously erudite the belongings from preceding data and this period have to apply it astutely. It will first categorize the fruit with its form and color and would settle the fruit designation as BANANA and put it in Banana group. Thus the machine learns the belongings from training data and then use the information to experiment information. Supervised learning categorized hooked on two classes:

3.1.2.1 Classification

Classification is an essential subject in ML that has to do with training machineries how to collection composed data by specific standards. Classification is the procedure where processors set data composed depend on prearranged features — this is entitled supervised learning. There is an unsupervised form of classification, called clustering where processors discovery communal physiognomies by which to collection data when groups are not stated. A shared instance of classification originates with sensing spam emails. To write a package to filter out spam emails, a processor computer operator can train a ML process with a traditional of spam-like emails proprietary as spam and even emails proprietary as not-spam. The imprint is to make a scheme that can learn features of spam emails from this training usual so that it can strainer available spam emails when it meetings novel emails [26]. Classification is an significant instrument in today's biosphere, where large facts is applied to brand all types of choices in government, finances, medication, and extra. Investigators have admission to enormous quantities of information, and classification is one instrument that aids them to type intelligence of the information and find designs. Though classification in ML needs the apple of (occasionally) composite procedures, classification is somewhat that persons do obviously every day. Classification is only group belongings composed rendering to alike topographies and features. Once you energy to a grocery stock, you can justly precisely collection the nourishments by nourishment collection (ounces, ovary, potatoes, essence, etc.) In ML, classification is all around education processors to do the similar [27].

3.1.2.2 Regression

To start with, the regression systems effort to estimation the charting purpose (f) from the input variables (x) to arithmetical or incessant output variables (y). Now, the production mutable could be a actual rate, which can be an integer or a floating point value. Consequently, the regression expectation glitches are typically amounts or dimensions. For instance, if you are providing with a dataset near houses, and you are requested to forecast their values, that are a regression job since the value will be a incessant production. Instances of the mutual regression systems comprise linear regression, Support Vector Regression (SVR), and regression trees [28].

3.1.2.2.1 Linear regression (LR)

LR is cast-off to forecast the worth of an consequence mutable Y based on one or additional input forecaster variables X . The goal is to found a linear association between the forecaster mutable(s) and the reply mutable, so that, we can usage this formulation to approximation the worth of the reply Y , when only the forecasters (Xs) standards are recognized. The goalmouth of a LR is to model the incessant Y mutable as a mathematical function of one or additional X variables, so we can usage this regression model to forecast Y when lone X is recognized. This mathematical equation can be widespread as shadows:

$$Y = \beta_1 + \beta_2 X + \epsilon \quad (3.1)$$

Where, β_1 is the intersection and β_2 is the slope. Taken together, they are named regression coefficients. error is the term error, part of the Y regression model powerless to clarify. The Figure 3.2 represented linear model example.

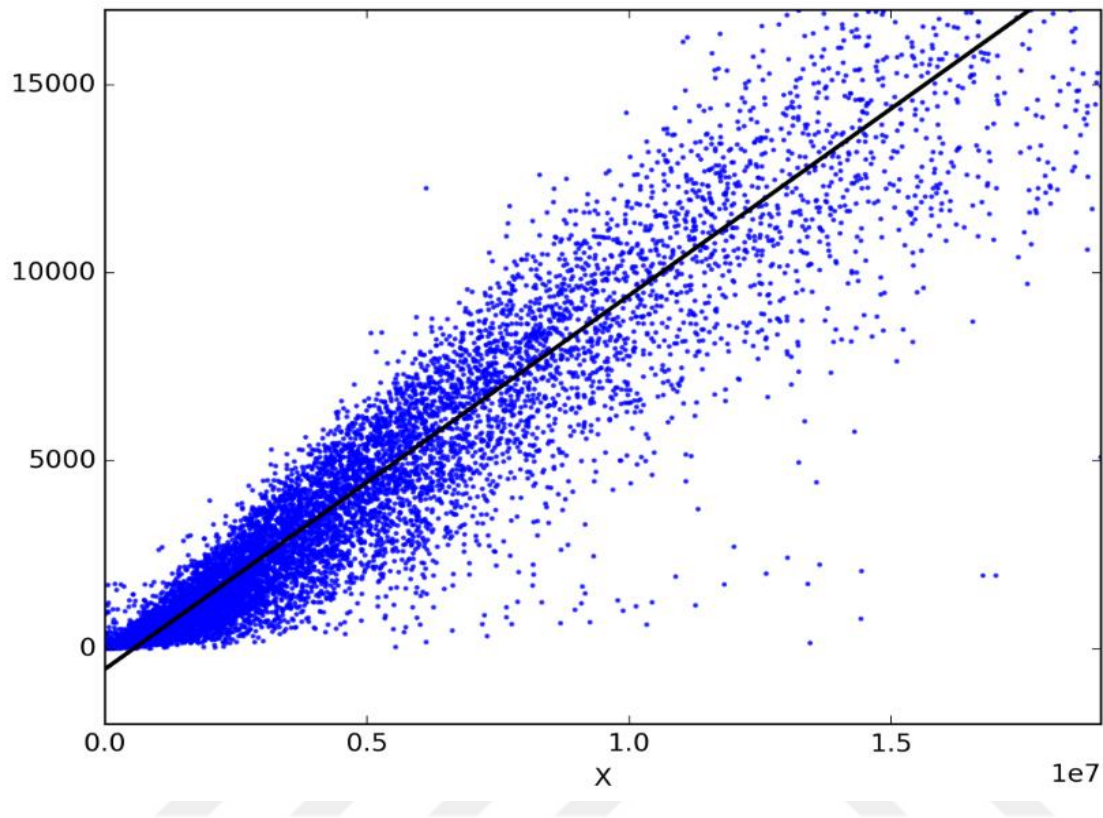


Figure 3.2: Linear Regression Model [29]

3.1.2.2.2 Logistic Regression (LR)

LR was applied in the biological sciences in initial twentieth period. It was then applied in several social science requests. LR is applied when the needy variable (target) is definite.

For instance,

To estimate whether an email is spam (1) or (0)

Whether the tumor is malignant (1) or not (0)

Reflect a situation where they want to categorize whether an email is spam or not. If they custom LR for this problematic, there is an essential for location up a verge depend on which recognition can be complete. Say if the real lesson is evil, foretold incessant value 0.4 and the verge worth is 0.5, the data opinion will be secret as not evil which can principal to thoughtful importance in actual period.

From this instance, it can be incidental that LR is not appropriate for organization problematic. LR is limitless, and this transports LR into image. Their worth severely varieties from 0 to 1 see Figure 3.3.

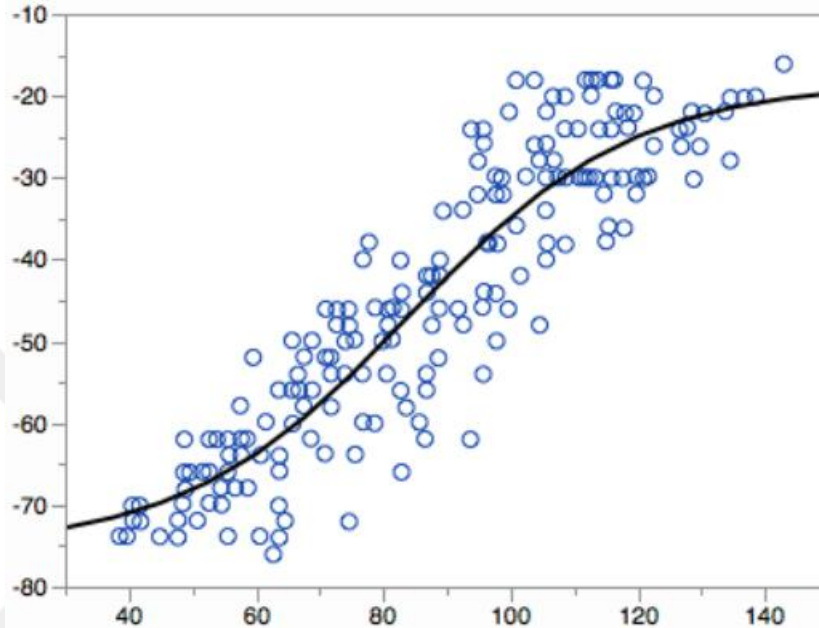


Figure 3.3: Logistic Regression [30]

3.1.2.2.3 Polynomial Regression

In statistics, polynomial regression is a procedure of regression examination in which the association among the self-governing parameter x and the needy variable y is demonstrated as an n th grade polynomial in x . Polynomial regression hysteric a nonlinear association among the worth of x and the consistent provisional cruel of y , denoted $E(y|x)$. Though polynomial regression hysteric a nonlinear model to the data, as a statistical approximation problematic it is linear, in the intelligence that the regression function $E(y|x)$ is linear in the unidentified factors that are expected after the data. For this aim, polynomial regression is careful to be a singular circumstance of manifold linear regressions. See Figure 3.4 as instance.

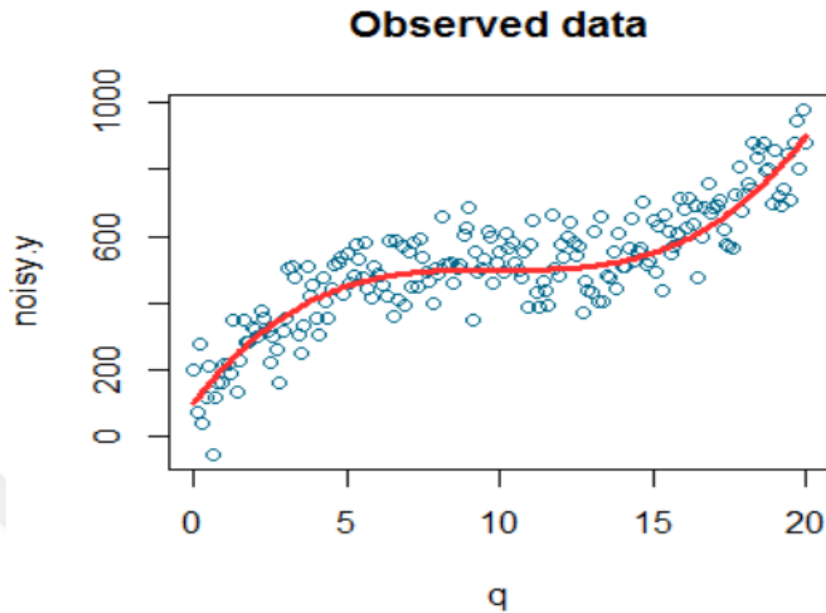


Figure 3.4: Polynomial Regression [31]

3.1.2.2.4 Stepwise Regression

Regression analysis is an extensively applied statistical method that pursues to classify relations among variables. The impression is to pond pertinent data to brand better-informed choices and is a shared repetition in the world of capitalizing. Stepwise regression is the step-by-step iterative building of a reversion model that includes involuntary assortment of sovereign variables. The obtainability of statistical software packages brands stepwise regression conceivable, even in replicas with hundreds of variables. The fundamental aim of stepwise regression is, finished a sequence of tests (F-tests, t-tests) to discovery a set of sovereign variables which meaningfully effect the helpless variable. This is complete with computers over iteration, which is the procedure of inward to outcomes or results by successful finished recurrent rounds or series of analysis. Leading tests mechanically with the assistance from arithmetical software letters has the benefit of saving time for the separate. The Figure 3.5 represented the example of Stepwise Regression.

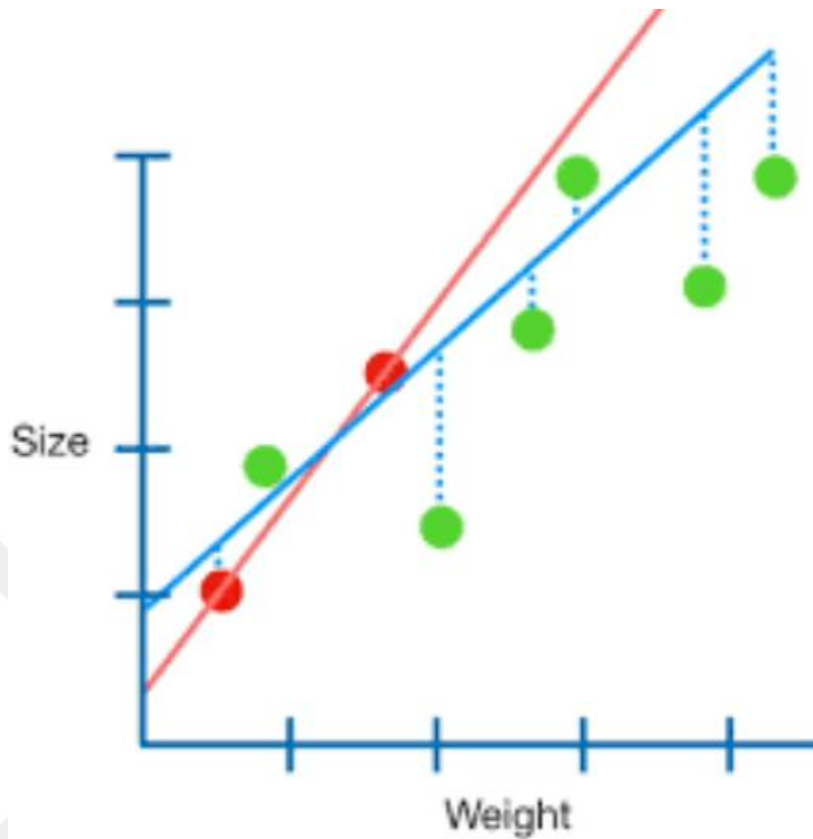


Figure 3.5: Stepwise Regression [32]

3.1.2.2.5 Lasso Regression

Lasso regression is a kind of linear regression that applied reduction. Reduction is where information standards are contracted to a dominant point, like the nasty. The lasso process inspires humble, sparse replicas (i.e. models with less parameters). This specific kind of regression is well-suited for replicas presentation tall stages of multicollinearity or when you poverty to mechanize sure parts of perfect selection, like variable parameter abolition. See Figure 3.6.

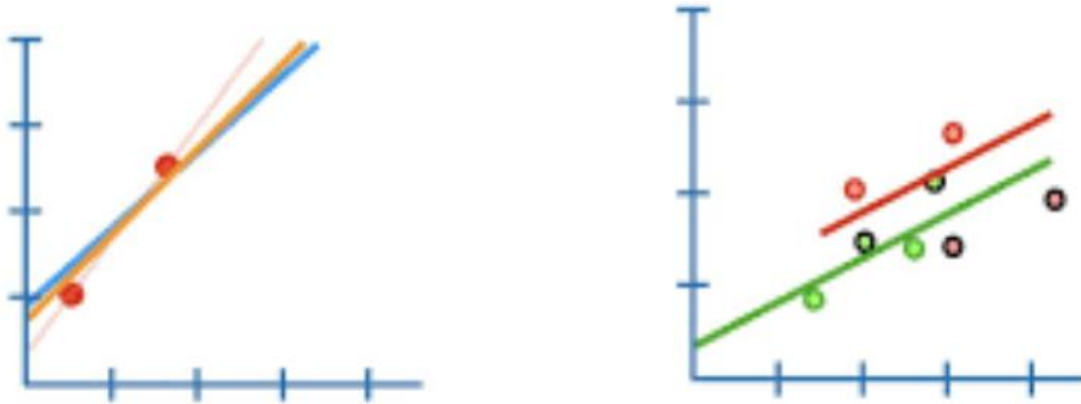


Figure 3.6: Lasso Regression [33]

3.1.2.2.6 Recurrent Neural Network (RNN)

Strict feedforward structural enterprise fixes not uphold a short-term reminiscence. Any reminiscence belongings are owing to the method historical inputs are re-presented to the network. A humble RNN has activation feedback which exemplifies short-term memory. A national layer is efficient not lone with the outside input of the network but also with activation after the earlier forward propagation. The feedback is adapted by a group of weights as to allow involuntary version finished learning (e.g. backpropagation) [34].

For humble structure and deterministic activation functions, learning can be attained applying alike gradient descent events to those foremost to the back-propagation technique for feed-forward networks. When the activations are stochastic, pretend hardening methods may be additional suitable. The next will appearance at a insufficient of the greatest significant kinds and features of RNN.

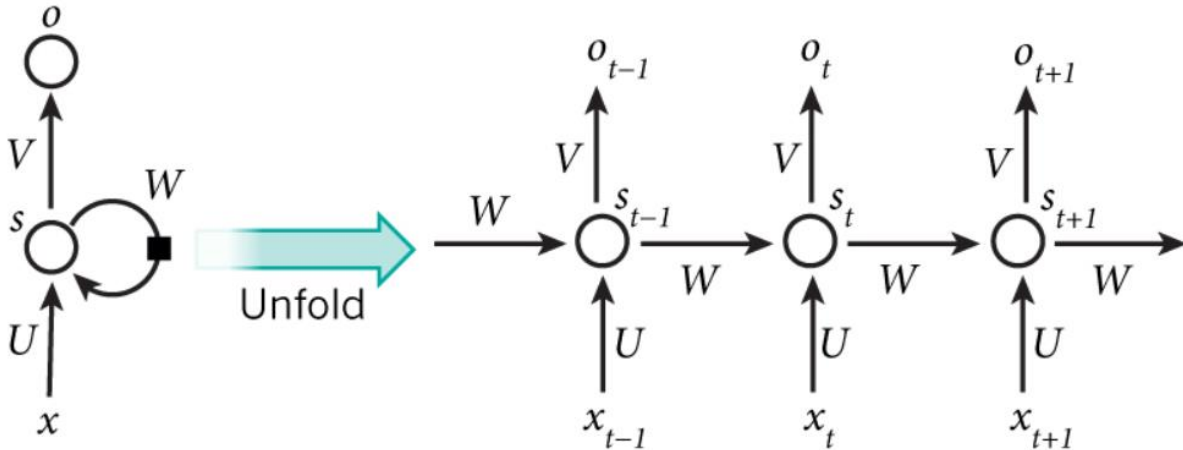


Figure 3.4: RNN Structure

3.1.2.2.7 Long Short Term Memory Networks (LSTM)

An LSTM has a alike switch movement as a RNN. It procedures data transitory on info as it broadcasts forward. The changes are the processes inside the LSTM's cells. The essential idea of LSTM's are the cell national, and it's numerous entrances. The cell state performance as a conveyance thoroughfare that transfers comparative information all the way depressed the order cable. Gates comprises sigmoid function. A sigmoid function is alike to the tanh function. In its place of squeezing standards between -1 and 1, it squelches standards between 0 and 1.

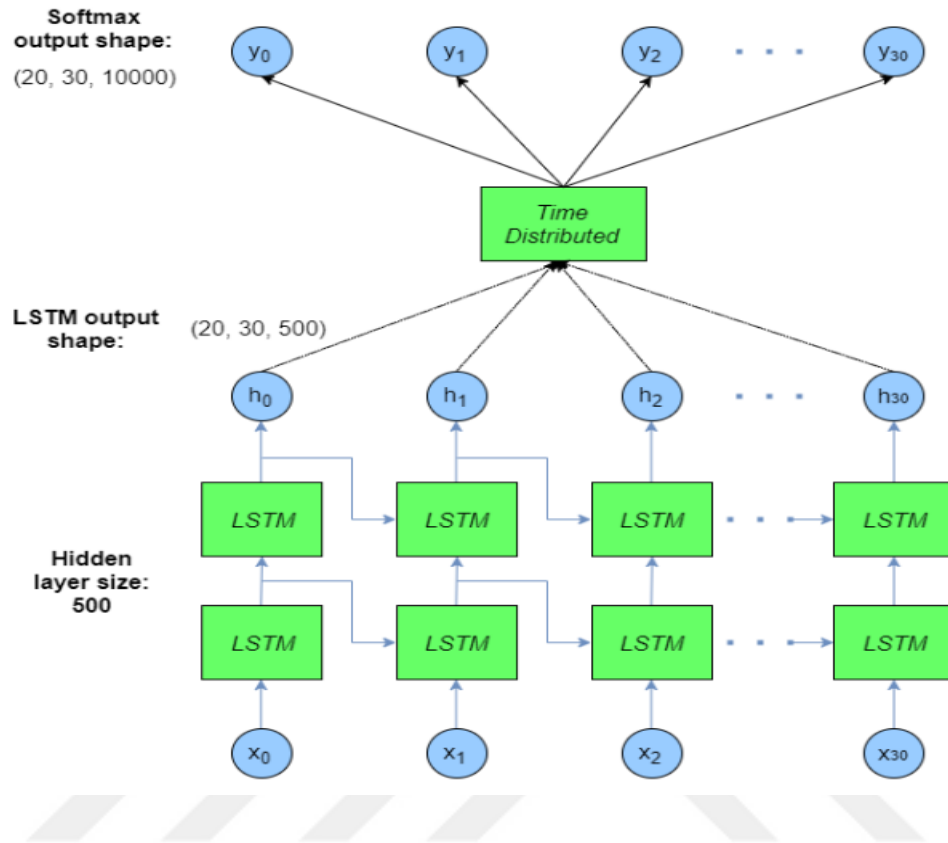


Figure 3.5: LSTM based SoftMax

Furthermore, structure of LSTM also presented in the Figure 3.6.

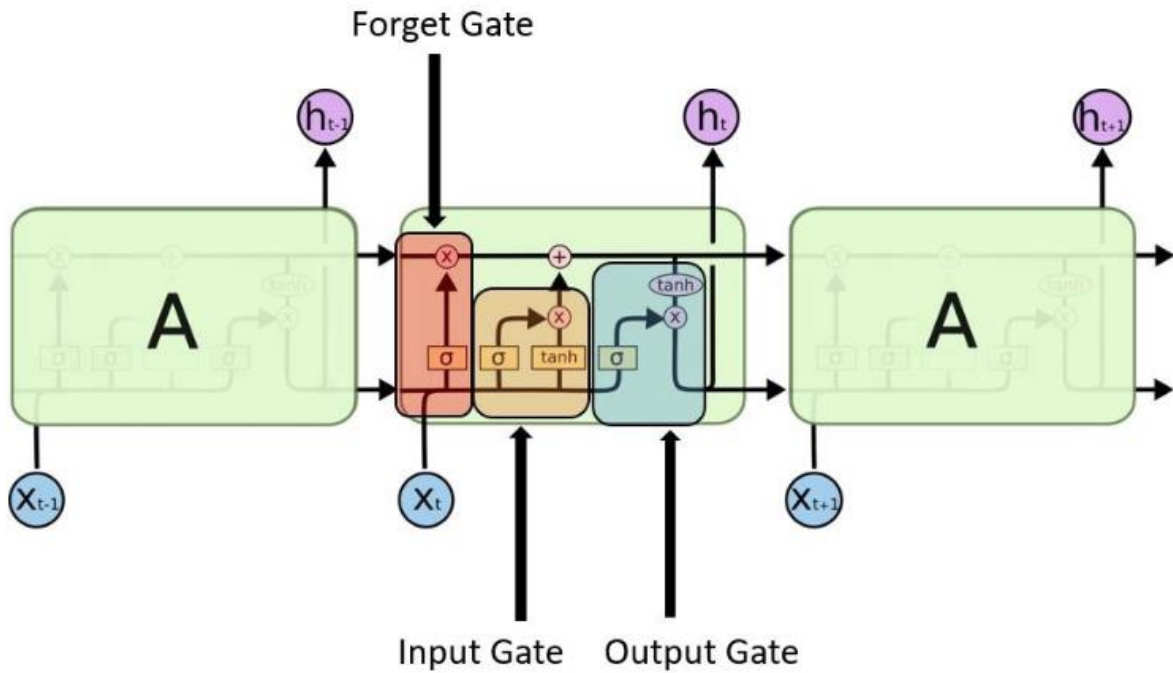


Figure 3.6: LSTM Structure

3.4 PROPOSED METHOD

In this section, new method presented presented to classify the heart sound into normal and abnormal by using LSTM based BBO. The BBO is optimization algorithm used to train the LSTM to obtain best performance. The overall system consists from design electronic Stethoscope by using Arduino. The Arduino system of electronic Stethoscope designed as shown in Figure 3.10. furthermore, new deep learning based system developed to and integrated with Arduino to decide automatically that the sound is normal or abnormal. The LSTM is widely used in sequential or time series problems, as it can learn long-term dependencies with its memory switch mechanism. Biogeography-based optimization (BBO) is an evolutionary algorithm (EA) that optimizes a function by stochastically and iteratively improving candidate solutions with regard to a given measure of quality, or fitness function. BBO belongs to the class of metaheuristics since it includes many variations, and since it does not make any assumptions about the problem and can therefore be applied to a wide class of problems. The flowchart of the proposed method presented in the 3.11.

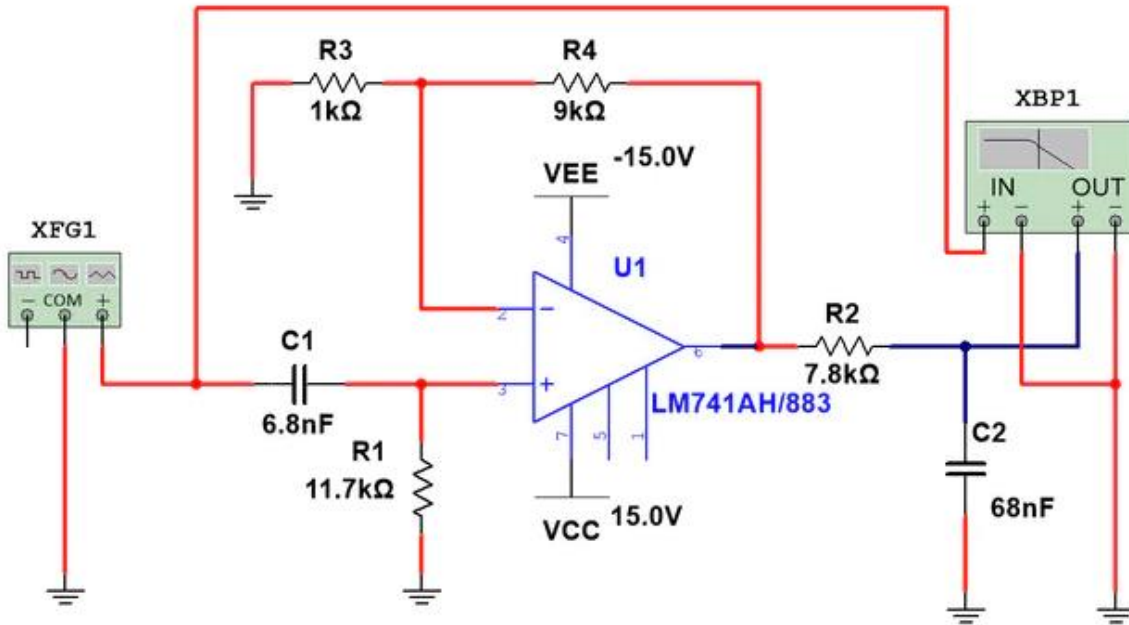


Figure 3.11: Arduino Structure

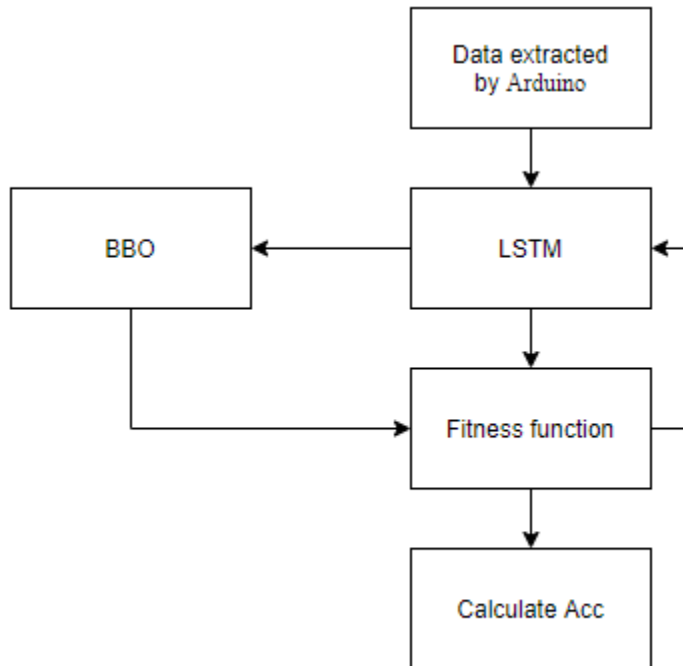


Figure 3.12: Proposed System

4. RESULTS

Several experiments are executed in various scenarios, the experiment and the result were assessed using various measurements, the act of various experiments was compared, and the results were highlighted.

The experimental implemented by using MATLAB2018 as tool. The dataset features that explained in the chapter 3 used as input to the proposed system that written by using MATLAB2020.

4.1 EVALUATION PARAMETERS

In this section four parameter are calculated for face recognition problem to evaluate our proposed method the calculated statistical parameters are: Accuracy is how close a measured value is to the actual (true) value.

The confusion matrix is used to evaluate the results of our method by calculating several parameters such as: True positives (TP), True negatives (TN), false positives (FP), and false negatives (FN).

4.2 VALIDATION USING RANDOM SUBSAMPLING

In this method, random sub-sampling validation is track for a secure amount of K iterations. Throughout apiece iteration it used random sampling minus spare, in instruction to choice a secure amount of S examples that brand up the examination set and are excepted from the training procedure of the perfect. The experiential test statistics are then be around over all iterations.

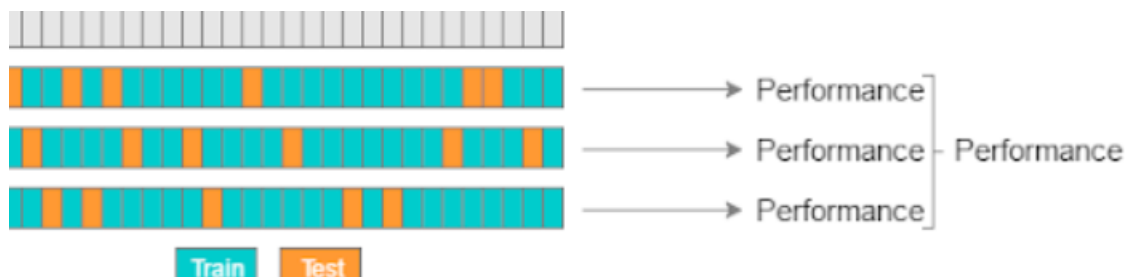


Figure 4.1: Random Subsampling

4.3 IMPLEMENTATION

In this section, RNN based ESD and BBO are presented for Classifying ECG to detect heart diseases. The data ECG test is important method used to diagnosis the heart diseases. In the same time it's too hard and time consuming for the doctors to diagnosis the disease by analysing the ECG signal. So, the computer aided systems assist the doctor to classify the ECG signal in to normal and abnormal to detect the heart diseases. In this study, the signal of each case are analysed and classified automatically. In the Figure 4.2 and Figure 4.3 presented the original signal of the Stethoscope.

Figure 4.2: ECG signal

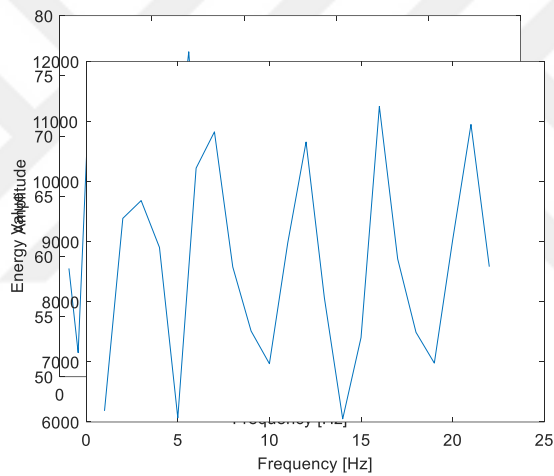


Figure 4.3: ECG signal after ESD

Then, the output of BBO wired to the LSTM that used to classify the signal to there is heart disease or not. This software can detect the heart disease issue in minimum time and with accurate results. The results of our method presented in Figure 4.3.

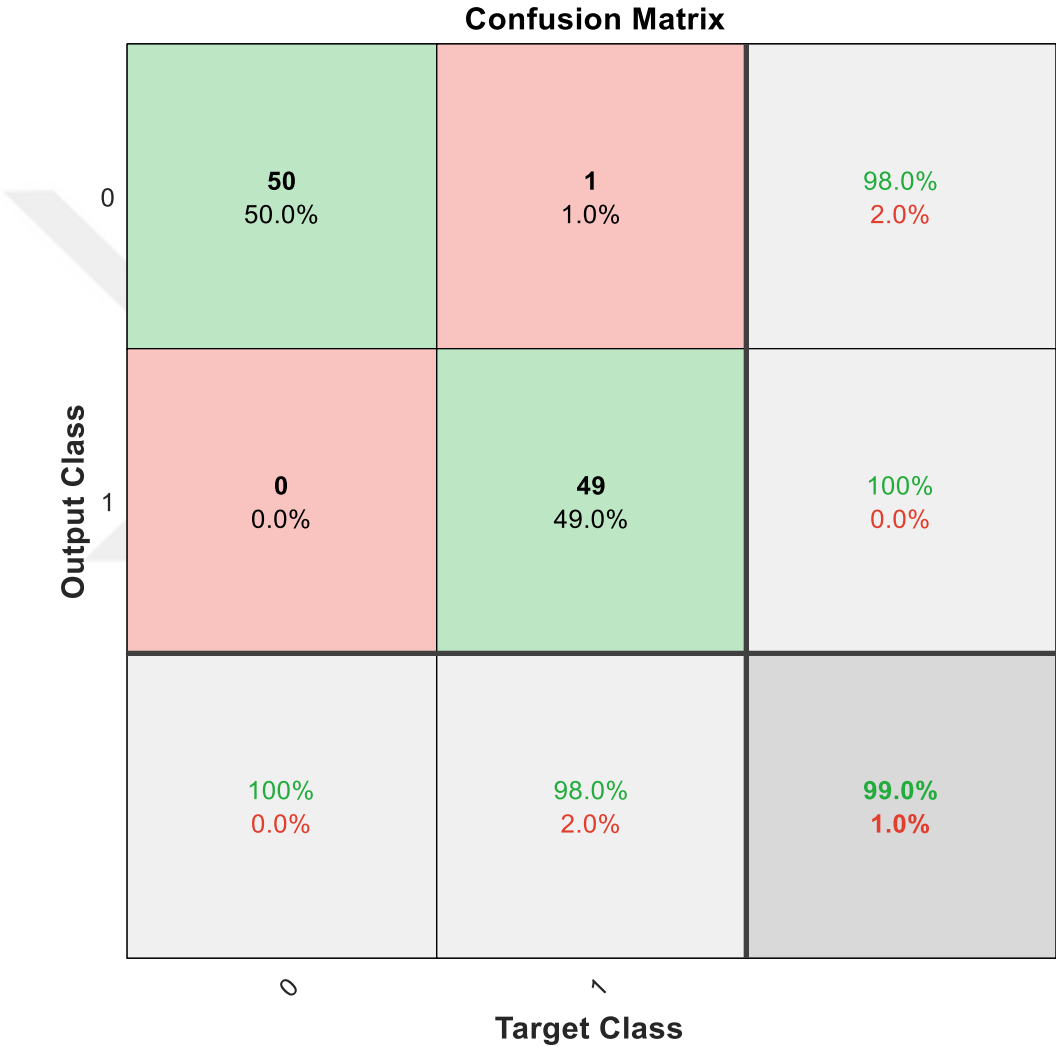
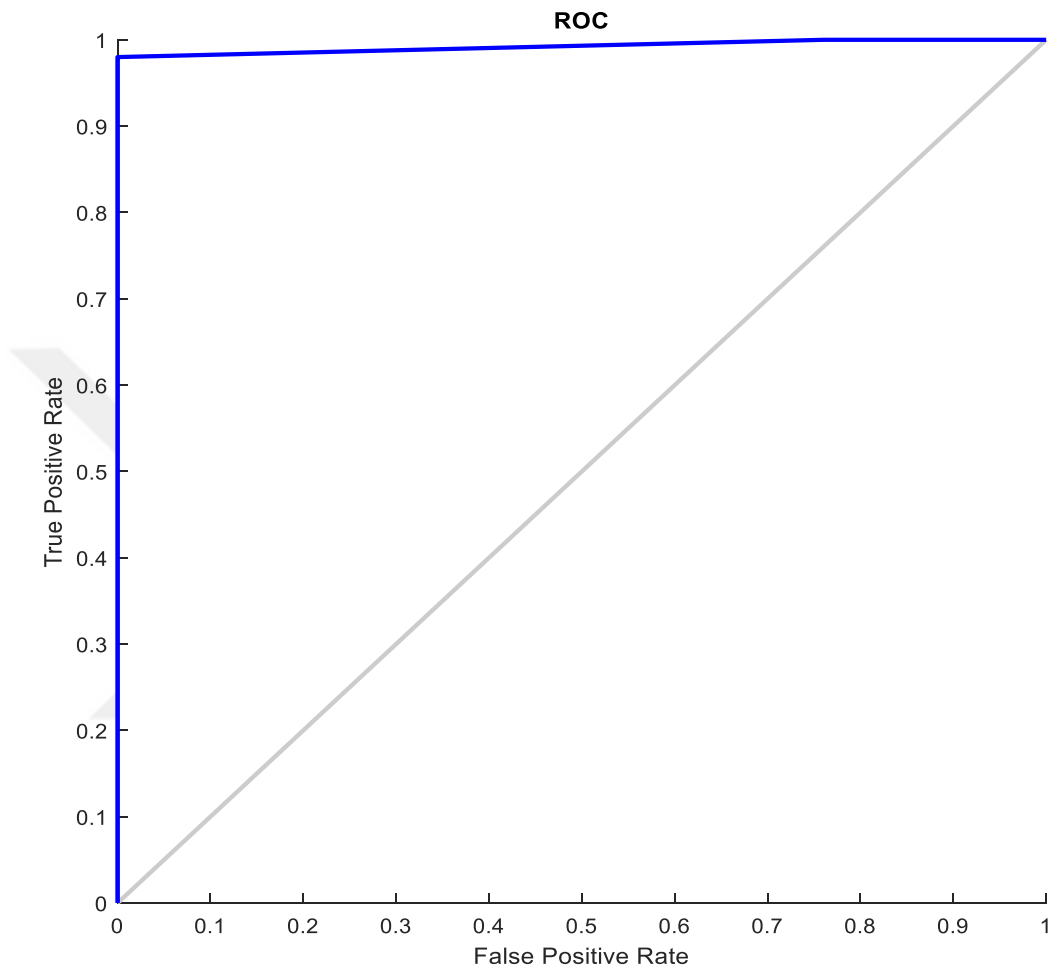


Figure 4.4: Confusion Matrix

The proposed method presented 99.21% accuracy which is remarkable when compared with well-known presented studies in this field. Furthermore, the roc curve also presented to validate the performance of our method see figure 4.5.

Figure 4.5: Roc Curve



On the other hand, the presented method compared with several studies presented in Table 4.1. the Table 4.1 show that our method supervir over previous studies and also the Figure 4.6 show the comparision to become more detail.

Table 4.1: Comparission

Reference	2 Accuracy %
[35]	82.7 95.4
[36]	90
[37]	79.9 79.1
[38]	90
[39]	96.79
Our Framework	99.21

5. CONCLUSION

In this study, new method presented for heart diseases detection by combining deep learning techniques based on optimization algorithm. In the first stage, LSTM applied to classify the heart signals that are obtained by Arduino. The BBO applied to enhance the performance of the LSTM by applied to reduce the error rate of the LSTM model. The presented method presented satisfactory results when compared with previous studies and presented 99.21% accuracy. BBO is an evolutionary algorithm (EA) that optimizes a function by improving possible solutions in a stochastic iterative manner with respect to a quality measure or fitness function. BBO belongs to the metaclass because it creates many options for fulfilling the assumptions about the problem and, therefore, can be used for a wide range of tasks.

As future work we advise to apply several optimization algorithms and obtained results compared with other methods. Furthermore, other deep learning techniques such as RNN, auto-encoders, and CNN can applied instead of LSTM which can presented different results which can discussed.

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APPENDIX

```
Z_Y_train=vec2mat(Z(:,(1:1:512)),2);
S_Y_train=vec2mat(S(:,(1:1:512)),2);
[m,n]=size(Z_Y_train);
for i = 1:1:m
Z_Pow(i)=sum ( abs (Z_Y_train(i,:)).^ 2);
S_Pow(i)=sum ( abs (S_Y_train(i,:)).^ 2);
end
Z_Pow_train = vec2mat(Z_Pow,256);
S_Pow_train = vec2mat(S_Pow,256);
figure
stem(S_Pow_train, '*')
hold on;
stem(Z_Pow_train, 'o')
xTrain= [Z_Pow_train;S_Pow_train];
%%%%%%%%%%%%%%
%
Z_Y_test=vec2mat(Z(:,(1:1:512)),2);
S_Y_test=vec2mat(S(:,(1:1:512)),2);
[k,j]=size(Z_Y_test);
for i = 1:1:k
```

```

Z_Pow(i)=sum ( abs (Z_Y_train(i,:)).^ 2);

S_Pow(i)=sum ( abs (S_Y_train(i,:)).^ 2);

end

Z_Pow_test = vec2mat(Z_Pow,256);

S_Pow_test = vec2mat(S_Pow,256);

figure

stem(S_Pow_test, '*')

hold on;

stem(Z_Pow_test, 'o')

xTest= [Z_Pow_test ; S_Pow_test];

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

xTrain=xTrain.';

xTest=xTest.';

tTrain=tTrain.';

tTest=tTest.';

%

rng('default')

SparseautoencoderSize1 = 40;

sparseautoencoder1 = trainAutoencoder(xTrain,SparseautoencoderSize1, ...

'MaxEpochs',400, ...

```

```
'L2WeightRegularization',0.004, ...
'SparsityRegularization',4, ...
'SparsityProportion',0.15, ...
'ScaleData', false);

sparseautoencoderfeat1 = encode(sparseautoencoder1,xTrain);

SparseautoencoderSize2 = 30;

sparseautoencoder2 = trainAutoencoder(sparseautoencoderfeat1,SparseautoencoderSize2, ...
'MaxEpochs',100, ...
'L2WeightRegularization',0.002, ...
'SparsityRegularization',4, ...
'SparsityProportion',0.1, ...
'ScaleData', false);

sparseautoencoderfeat2 = encode(sparseautoencoder2,sparseautoencoderfeat1);

softnet = trainSoftmaxLayer(sparseautoencoderfeat2,tTrain,'MaxEpochs',400);

deepnet = stack(sparseautoencoder1,sparseautoencoder2,softnet);

deepnet = train(deepnet,featuresTest,tTest);

y = deepnet(featuresTest);

plotconfusion(tTest,y);
```