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# Predicting of Heart Diseases by Using Artificial Intelligence Technique

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**Abstract:** The heart is the most vital organ in the human body if there is any disease in the heart all body organs will be affected, it even may lead to death. And because most of the deaths occurring in the world are caused by heart disease, attention should be paid .to patients with heart disease and to provide medicines, medical stuff and equipment prior to the operation without delaying one minute for patient safety. The idea of this project is to predict heart disease using artificial intelligence by predicting the number , date, age and gender of patients with heart disease who will come to the hospital, and bring appropriate amount of medicines, not excess of need and not less that we need.

**Keywords:** heart diseases, medical stuff, bring appropriate, human body, artificial intelligence

## 1.1 Introduction

Health sector is the most important types of service and health sectors and economic and social units because of its concerns about human life and society and the process of identifying medicines

and medical supplies in the form of health is one of the factors that affect the quality of services provided to patients and the community and not only to provide medicines and reduce the costs resulting from surplus storage and expiration of validity Of the medicine and to Make hospital management smart and convert all data to digital data and also to predict the number of patients and types of diseases during a certain period all this in the interest of health and safety of patients through the provision of medicines and medical supplies and medical staff of doctors, nurses and patients beds and this will help significantly in the health care This is done by inserting data for days, weeks, months, or years prior to patients in one of the artificial intelligence techniques, neural networks, which will give us the results of prediction In this research, a proficient methodology for the extraction of significant patterns from the Heart Disease warehouses for heart attack prediction, which unfortunately continues to be a leading cause of mortality in the whole world Recently, neural network ensembles have been successfully utilized in a variety of applications including to assist in medical diagnosis. Neural network ensembles can significantly improve the generalization ability of learning systems through training a ANNs have .]finite number of neural networks and then combining their results [1 been applied in various medical fields, constituting themselves as a useful technique in clinical practice], such as cardiology, oncology, pathology, endocrinology, radiology, urology, pneumonology, pediatrics , and children surgery . Medicine is a field that ANNs can be proven as a powerful tool to enhance current medical techniques Probabilistic Neural Networks (PNNs) Used to predict osteoporosis [2]

### 1.2 The Aim of the Project

The aim of the project is to make the hospital management smart and predict the number of patients, their age, gender, type of heart disease and date of arrival to the hospital using artificial intelligence techniques .To provide medicine ,medical staff patients beds and all the medical supplies needed by the patient before the operation.

And also to determine the amount of medication sufficient to meet the needs of the hospital and patients.

2. 1-Anatomy& physiology

### 2.1.1 The Circulatory System

The circulatory system, also called the cardiovascular system or the vascular system, is an organ system that permits blood to circulate and transport nutrients (such as amino acids and electrolytes), oxygen, carbon dioxide, hormones, and blood cells to and from the cells in the body to provide nourishment and help in fighting diseases, stabilize temperature and pH, and maintain homeostasis.

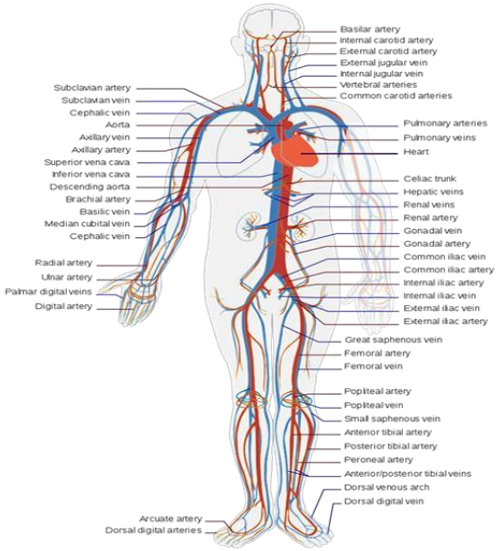


**Fig. (2.1) The circulatory system[3].**

The essential components of the human cardiovascular system are the heart, blood and blood vessels.[6] It includes the pulmonary circulation, a "loop" through the lungs where blood is oxygenated; and the systemic circulation, a "loop" through the rest of the body to provide oxygenated blood. The systemic circulation can also be seen to function in two parts – a macro circulation and a microcirculation. An average adult contains five to six quarts (roughly 4.7 to 5.7 liters) of blood, accounting for works with the circulatory system to provide the nutrients the system needs to keep the heart pumping [3].

### 2.1.2 The Main Component of the Circulatory System

### A. Heart

The heart pumps oxygenated blood to the body and deoxygenated blood to the lungs. In the human heart there is one atrium and one ventricle for each circulation, and with both a systemic and a pulmonary circulation there are four chambers in total: left atrium, left ventricle, right atrium and right ventricle. The right atrium is the upper chamber of the right side of the heart. The blood that is returned to the right atrium is deoxygenated (poor in oxygen) and passed into the right ventricle to be pumped through the pulmonary artery to the lungs for re-oxygenation and removal of carbon dioxide. The left atrium receives newly oxygenated blood from the lungs as well as the pulmonary vein which is passed into the strong left ventricle to be pumped through the aorta to the different organs of the body [3].

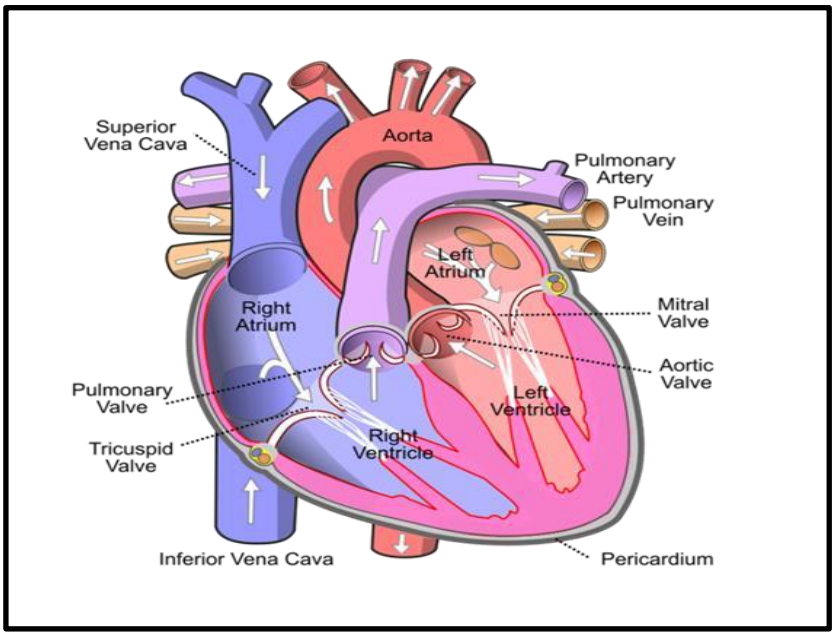


**Fig. (2.2)Heart[3].**

### B. Arteries

Oxygenated blood enters the systemic circulation when leaving the left ventricle, through the aortic semilunar valve. The first part of the systemic circulation is the aorta, a massive and thick-walled artery. The aorta arches and gives branches supplying the upper part of the body after passing through the aortic opening of the diaphragm at the level of thoracic ten vertebras, it enters the abdomen. Later it descends down and supplies branches to abdomen, pelvis, perineum and the lower limbs. The walls of aorta are elastic. This elasticity helps to maintain the blood pressure throughout the body. When the aorta receives almost five liters of blood from the heart, it recoils and is responsible for pulsating blood pressure. Moreover, as aorta branches into smaller arteries, their elasticity goes on decreasing and their compliance goes on increasing [3].

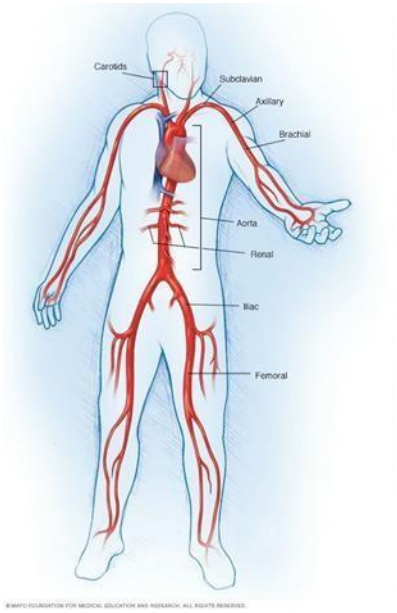


**Fig. (2.3)Human Arteries [19].**

## C-Capillaries

Arteries branch into small passages called arterioles and then into the capillaries. The capillaries merge to bring blood into the venous system [3].

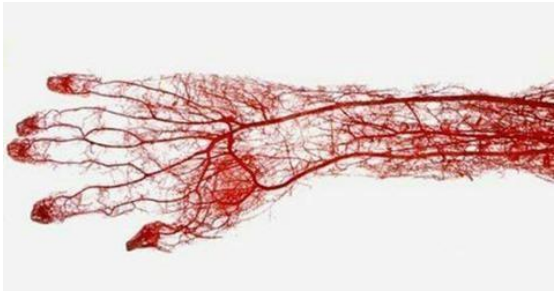

**Fig. (2.4)capillaries of the human body[20].**

## D-Veins

Capillaries merge into venules, which merge into veins. The venous system feeds into the two major veins: the superior vena cava – which mainly drains tissues above the heart – and the inferior vena cava – which mainly drains tissues below the heart.

These two large veins empty into the right atrium of the heart.

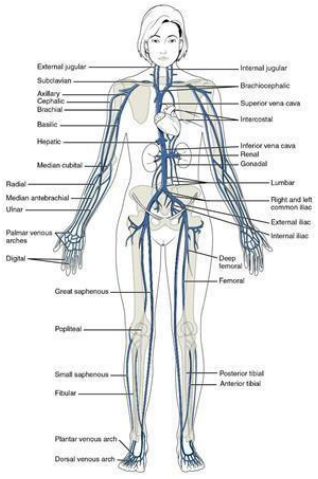


**Fig.(2.5)the human veins [21].**

### E-Portal veins

The general rule is that arteries from the heart branch out into capillaries, which collect into veins leading back to the heart. Portal veins are a slight exception to this. In humans the only significant example is the hepatic portal vein which combines from capillaries around the gastrointestinal tract where the blood absorbs the various products of digestion; rather than leading directly back to the heart, the hepatic portal vein branches into a second capillary system in the liver [3].

### F-Lungs

The circulatory system of the lungs is the portion of the cardiovascular system in which oxygen-depleted blood is pumped away from the heart, via the pulmonary artery, to the lungs and returned, oxygenated, to the heart via the pulmonary vein. Oxygen deprived blood from the superior and inferior vena cava enters the right atrium of the heart and flows through the tricuspid valve (right atrioventricular valve) into the right ventricle, from which it is then pumped through the pulmonary semilunar valve into the pulmonary artery to the lungs. Gas exchange occurs in the lungs, whereby CO2 is released from the blood, and oxygen is absorbed. The pulmonary vein returns the now oxygen-rich blood to the left atrium. A separate system known as the bronchial circulation supplies blood to the tissue of the larger airways of the lung.[3]

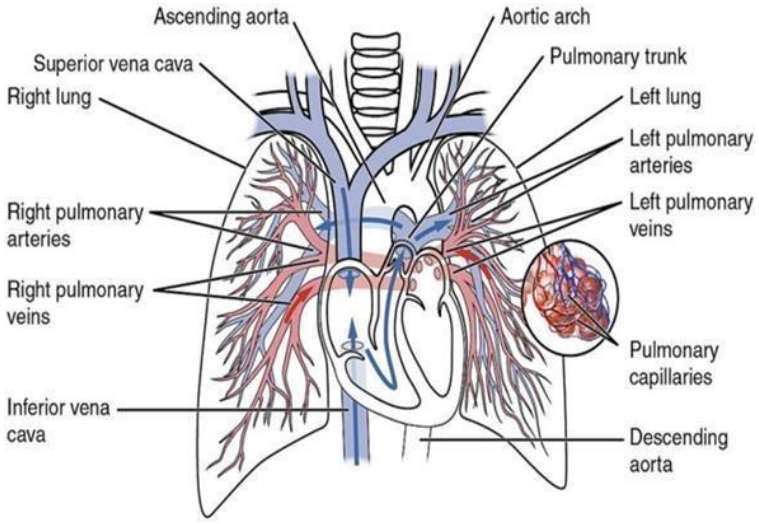


**Fig. (2.6) lung of human [3].**

## 2.2 Some Heart Diseases Have Been Studied In

### *3.1 Artificial Intelligence Definition*

Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction[14].

### 3.1.1 Types of artificial intelligence

### A. Type 1: Reactive machines

An example is Deep Blue, the IBM chess program. Deep Blue can identify pieces on the chess board and make predictions, but it has no memory and cannot use past experiences to inform future ones. It analyzes possible moves.

### B. Type 2: Limited memory

These AI systems can use past experiences to inform future decisions. Some of the decision-making functions in self-driving cars are designed this way. Observations inform actions happening in the not-so-distant future, such as a car changing lanes.

These observations are not stored permanently.

### C. Type 3: Theory of mind

This psychology term refers to the understanding that others have their own beliefs, desires and intentions that impact the decisions they make. This kind of AI does not yet exist.

### D. Type 4: Self-awareness

In this category, AI systems have a sense of self, have consciousness. Machines with self-awareness understand their current state and can use the information to infer [what others are feeling. This type of AI does not yet exist[14].

## 3.2 Machine Learning

Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning over time in autonomous fashion, by feeding them data and information in the form of observations or "Machine Learning at its most basic is the practice of using algorithms to parse data, learn from it, and then make a determination or prediction about something in the world

### *3.2.1 Machine Learning Basic Concepts*

There are many different types of machine learning algorithms, and they're typically grouped by either learning style (ie supervised learning, unsupervised learning, semisupervised learning) or by similarity in form or function (ie classification, regression, decision tree, clustering, deep learning, etc.). Regardless of learning style or function.

### 3.2.2 Combinations of machine learning algorithms

1. Representation (a set of classifiers or the language that a computer understands).
2. Evaluation (aka objective/scoring function).
3. Optimization (search method; often the highest-scoring classifier, for example; there are both off-the-shelf and custom optimization methods used).[15]

| Representation | Evaluation | Optimization |
|---|---|---|
| Instances | Accuracy/Error rate | Combinatorial optimization |
| *K*-nearest neighbor | Precision and recall | Greedy search |
| Support vector machines | Squared error | Beam search |
| Hyperplanes | Likelihood | Branch-and-bound |
| Naive Bayes | Posterior probability | Continuous optimization |
| Logistic regression | Information gain | Unconstrained |
| Decision trees | K-L divergence | Gradient descent |
| Sets of rules | Cost/Utility | Conjugate gradient |
| Propositional rules | Margin | Quasi-Newton methods |
| Logic programs | | Constrained |
| Neural networks | | Linear programming |
| Graphical models | | Quadratic programming |
| Bayesian networks | | |
| Conditional random fields | | |

**Table. (3.1) component of machine learning [15].**

## 3.3 Deep Learning Definition

Deep Learning is a new research area that deals with the creation of theories and algorithms that allow the machine to learn by itself by simulating neurons in the human body. And one branch of science that deals with artificial intelligence. Is one of the branches of the science of machine learning, most of the in-depth learning research focuses on finding methods for devising a high degree of strippers by analyzing a large data set using linear and nonlinear transformations or, deep

learning is a class of machine learning algorithms that use multiple layers of neural networks to progressively extract higher level features from raw input [16].

### 3.4 Neural Networks Definition

A neural network is a type of machine learning which models itself after the human brain. This creates an artificial neural network that via an algorithm allows the computer to learn by incorporating new data.

Neural networks are able to perform what has been termed deep learning. While the basic unit of the brain is the neuron, the essential building block of an artificial neural network is a perceptron which accomplishes simple signal processing, and these are then connected into a large mesh network [17].

ANNs use a method known as back propagation to tune and optimize the results. Back propagation is a two-step process, where the inputs are fed into the neural network via forward propagation and multiplied with (initially random) weights and bias before they are transformed via an activation function. The depth of your neural network will depend on how many transformations your inputs should go through. Once the forward propagation is complete, the back propagation step measures the error from your final output to the expected output by calculating the partial derivatives of the weights generating the error and adjusts them. Once the weights are adjusted, the model will repeat the process of the forward and back propagation steps to minimize the error rate until convergence. If you notice how the inputs are aligned in Fig.(3.1), you will see that this is an ANN with only one hidden layer, so the back propagation will not need to perform multiple gradient descent calculations [18].

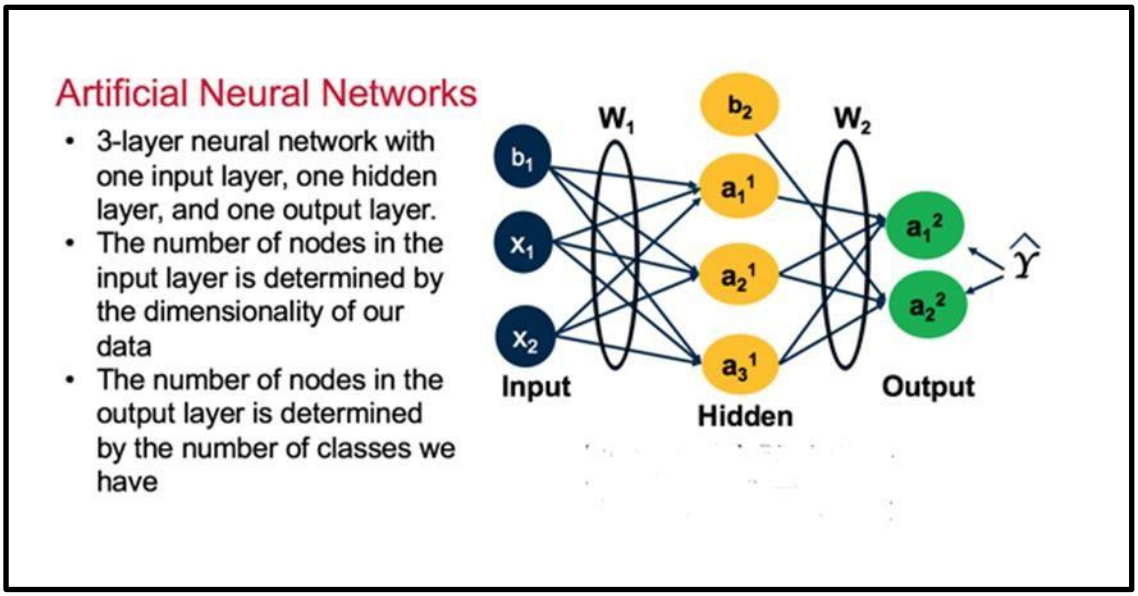


**Fig .(3.1) layers of ANN[18].**

#### 3.4.1 Types of Neural Networks

1. Feedforward
2. Auto encoder
3. Probabilistic
4. Time delay
5. Regulatory feedback
6. Convolutional (CNN)
7. Recurrent Neural Networks

8. Other types [17].

### 3.5 Recurrent Neural Network

Recurrent Neural Networks (RNNs) are called recurrent because they perform the same computations for all elements in a sequence of inputs. RNNs are becoming very popular due to their wide utility. They can analyze time series data, such as stock prices, and provide forecasts.

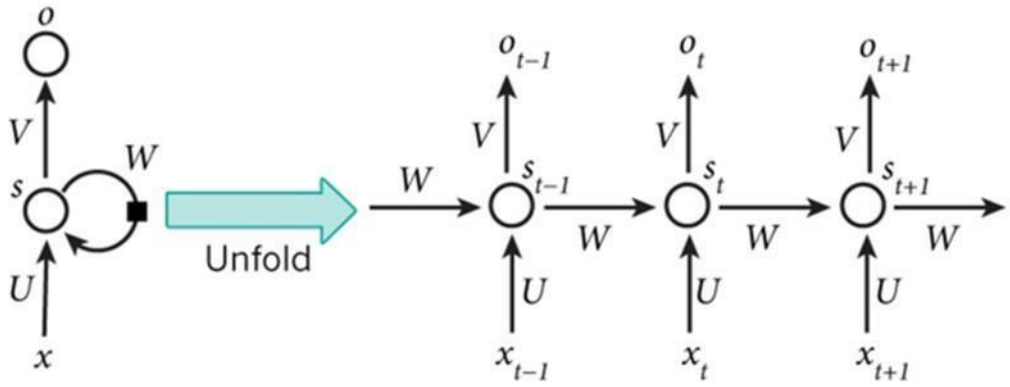


**Fig. (3.2) RNN architecture [18].**

Shows an example of an RNN architecture, and we see xt is the input at time step t. For example, x1 could be the first value in time period one. st is the hidden state at time step tn and is calculated based on the previous hidden state and the input at the current step, using an activation function. St-1 is usually initialized to zero. ot is the output at step t. For example, if we wanted to predict the next value in a sequence, it would be a vector of probabilities across our time series RNN cells are developed on the notion that one input is dependent on the previous input by having a hidden state or memory that captures what has been seen so far. The value of the hidden state at any point in time is a function of the value of the hidden state at the previous time step and the value of the input at the current time step. RNNs have a different structure than ANNs and use back propagation through time (BPTT) to compute the gradient descent after each iteration [18].

## CHAPTER FOUR

## Methodology

### 4.1 Data collection

We went to Ibn al-Nafis hospital and found the data written in warehouses and it took a very long time to write. The data we used was the first four months of 2017.

### 4.2 pre-processing digitizing

All four months of data were entered into the Excel program. The written data was converted to numbers. There are six columns, the first one from left for years, the second one for months, the third one for numbers of patients, the fourth one for gender type, the fifth one for age of each patient and the sixth one for type of disease

| year | months | no | gender | age | disease |
|---|---|---|---|---|---|
| 2017 | january | 1 | 2 | 38 | 2 |
| 2017 | january | 2 | 2 | 32 | 2 |
| 2017 | january | 3 | 1 | 80 | 1 |
| 2017 | january | 4 | 2 | 52 | 3 |
| 2017 | january | 5 | 1 | 70 | 1 |
| 2017 | january | 6 | 1 | 70 | 4 |
| 2017 | january | 7 | 2 | 75 | 4 |
| 2017 | january | 8 | 2 | 39 | 1 |
| 2017 | january | 9 | 2 | 61 | 5 |
| 2017 | january | 10 | 2 | 46 | 5 |
| 2017 | january | 11 | 2 | 59 | 1 |
| 2017 | january | 12 | 2 | 60 | 1 |
| 2017 | january | 13 | 1 | 80 | 5 |
| 2017 | january | 14 | 2 | 80 | 6 |
| 2017 | january | 15 | 1 | 82 | 1 |
| 2017 | january | 16 | 2 | 58 | 2 |
| 2017 | january | 17 | 2 | 12 | 7 |
| 2017 | january | 18 | 1 | 70 | 2 |
| 2017 | january | 19 | 2 | 64 | 10 |
| 2017 | january | 20 | 1 | 27 | 5 |
| 2017 | january | 21 | 2 | 71 | 1 |
| 2017 | january | 22 | 2 | 60 | 5 |
| 2017 | january | 23 | 2 | 80 | 1 |
| 2017 | january | 24 | 1 | 70 | 9 |

**Table (4.1)Data in excel.**

In column of diseases coronary artery disease was represented to (1), myocardiac infarction to (2), Cardiomyopathie to ( 3), cardiac insufficiency to ( 4), Angina to ( 5), high blood pressure to ( 6), tetralogy of fallot to ( 7), Anemia to ( 8), heart arrhythmia to (9), and palpitations to (10)

### 4.3 statistical methods

Enter the data in the SPSS program For the purpose of statistics and to find mean , standard deviation.

| | | | | | |
|---|---|---|---|---|---|
| 1 | Descriptive Statistics | | | | |
| 2 | Dependent Variable: | | age | | |
| 3 | disease | gender | Mean | Std. Deviat | N |
| 4 | coonary ar | Female | 60.72 | 12.447 | 386 |
| 5 | | Male | 56.2 | 12.176 | 659 |
| 6 | | Total | 57.87 | 12.464 | 1045 |
| 7 | myocardia | Female | 59.52 | 15.032 | 71 |
| 8 | | Male | 53 | 11.086 | 231 |
| 9 | | Total | 54.54 | 12.414 | 302 |
| 10 | cardio myc | Female | 54.57 | 14.68 | 14 |
| 11 | | Male | 58.12 | 14.57 | 25 |
| 12 | | Total | 56.85 | 14.518 | 39 |
| 13 | cardiac ins | Female | 62.8 | 12.844 | 101 |
| 14 | | Male | 60.04 | 16.05 | 140 |
| 15 | | Total | 61.2 | 14.826 | 241 |
| 16 | angina | Female | 60.21 | 10.43 | 105 |
| 17 | | Male | 57.19 | 11.704 | 208 |
| 18 | | Total | 58.2 | 11.366 | 313 |
| 19 | high blood | Female | 54.13 | 17.511 | 31 |
| 20 | | Male | 52.17 | 17.628 | 18 |
| 21 | | 6 | 26 | . | 1 |
| 22 | | Total | 52.86 | 17.649 | 50 |
| 23 | tetralogy of | Female | 10 | 9.899 | 2 |
| 24 | | Male | 14 | 3.559 | 4 |
| 25 | | Total | 12.67 | 5.61 | 6 |
| 26 | anemia | Female | 55.67 | 21.194 | 18 |
| 27 | | Male | 48.6 | 26.595 | 5 |
| 28 | | Total | 54.13 | 22.013 | 23 |
| 29 | heart arrhy | Female | 65.85 | 14.772 | 27 |
| 30 | | Male | 61.04 | 16.794 | 25 |
| 31 | | Total | 63.54 | 15.807 | 52 |

**Table(4.2) Descriptive statistics in SPSS.**

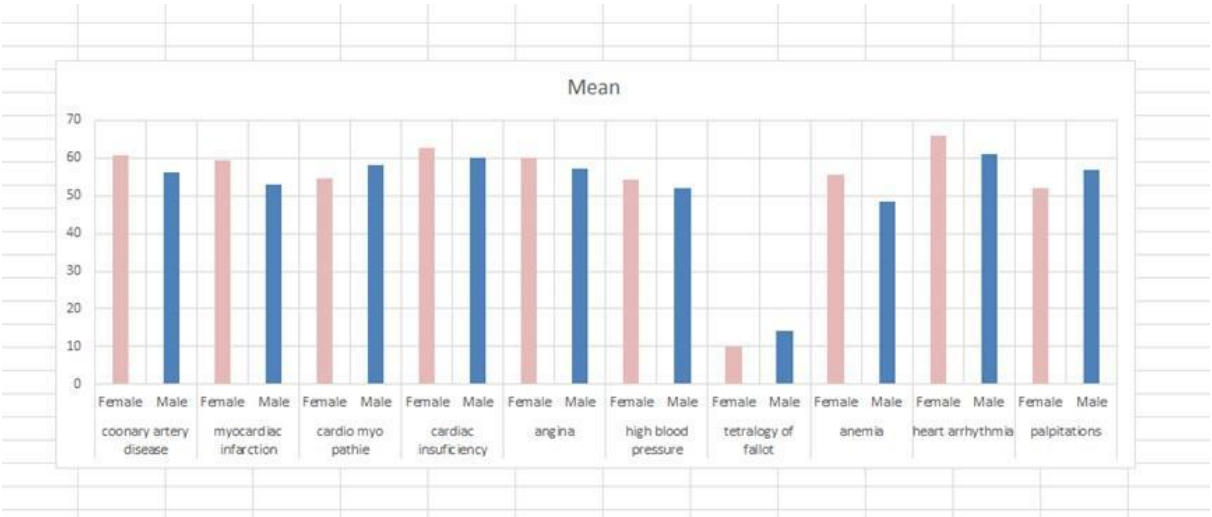


**Fig.(4.2) mean of age in male and female of in SPSS for each.**

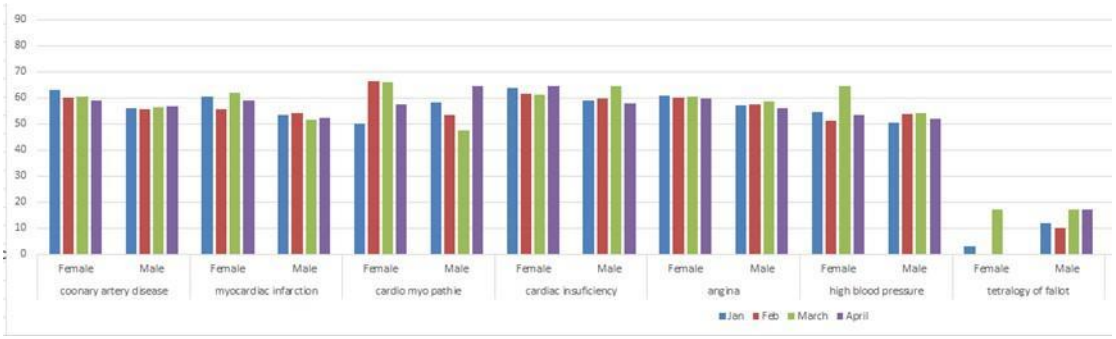


**Fig.(4.3) graph of Distribution of gender over the mon.**

### 4.4 Programming

For the purpose of prediction, we will use the orange program.We select the file that containing the data we want to predict and chose the linear regression and random forest model which are responsible for prediction.

**Fig (4-4) shape of orange program logo[23].**

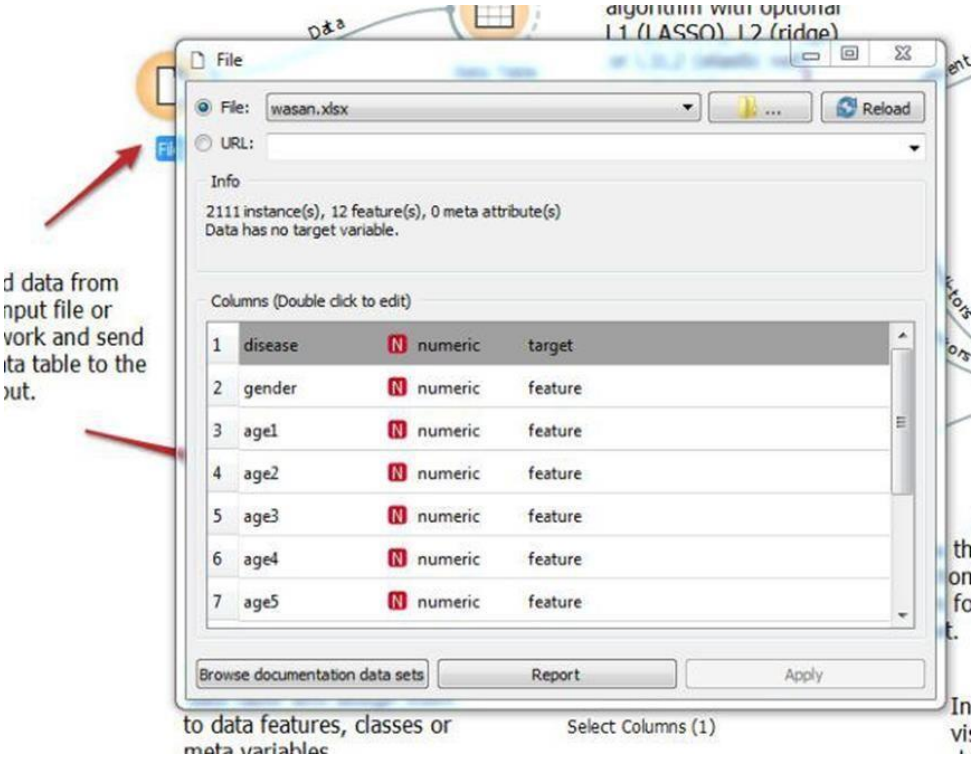


**Fig. (4.5) chose the wanted file.**

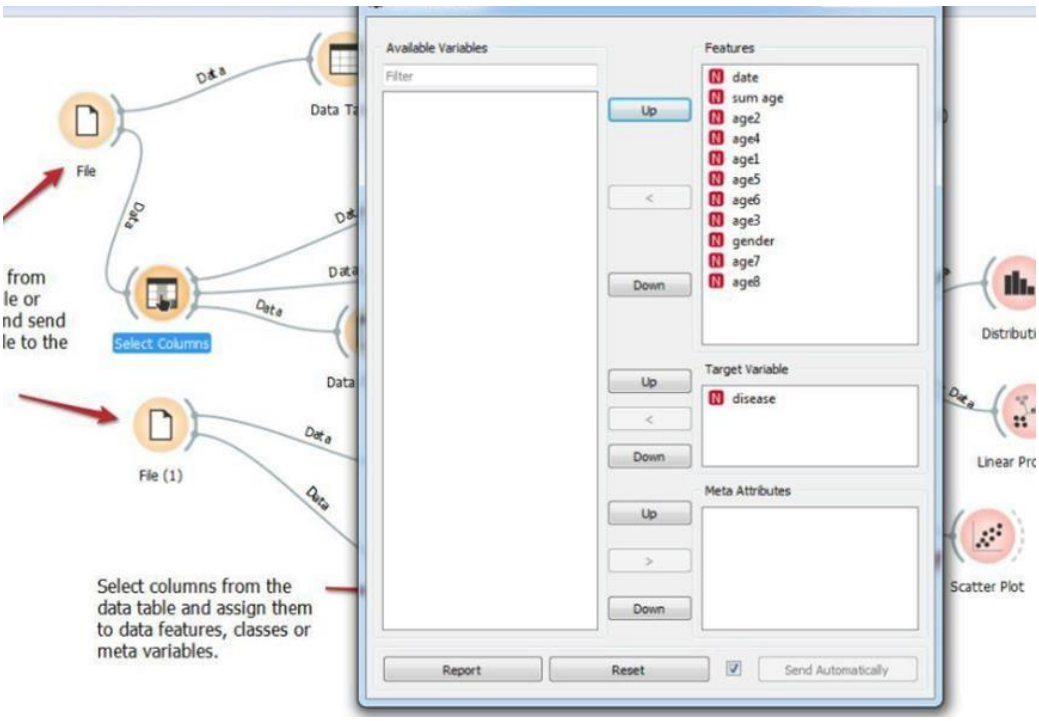


**Fig. (4.6) select the target column.**

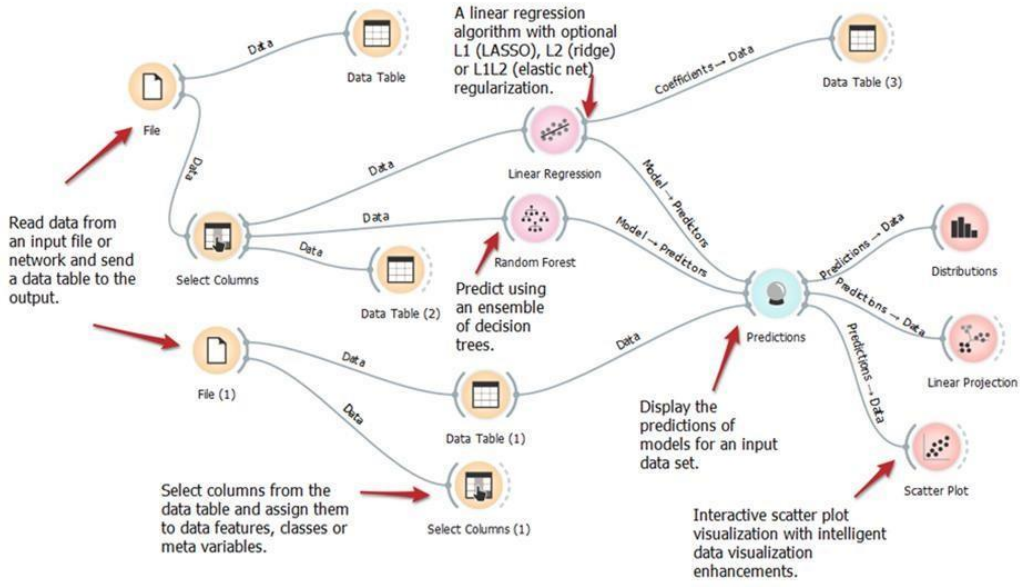


**Fig. (4.7) work field of orange.**

## Results

We chose three diseases randomly. These diseases are myocardial infarction, angina and high blood pressure.

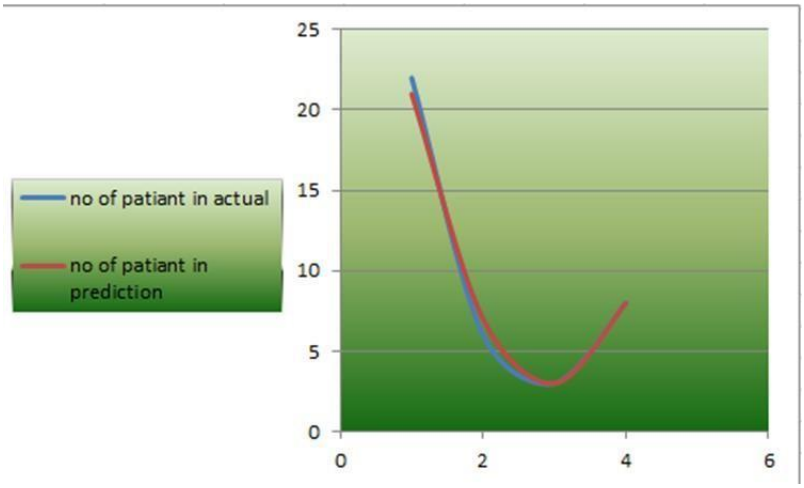


**Fig. (5.1) numbers of patient in myocardial infarction.**

This image of number of heart patients for myocardial infraction for the first four months of 2018, The y-axis is for patients number and x-axis is for months, The red line is for predictive results, blue line for actual number. The actual result for the first four months are 22,6,3 and 8 respectively, The predictive result for the four months are 21,7,3 and 8**.**

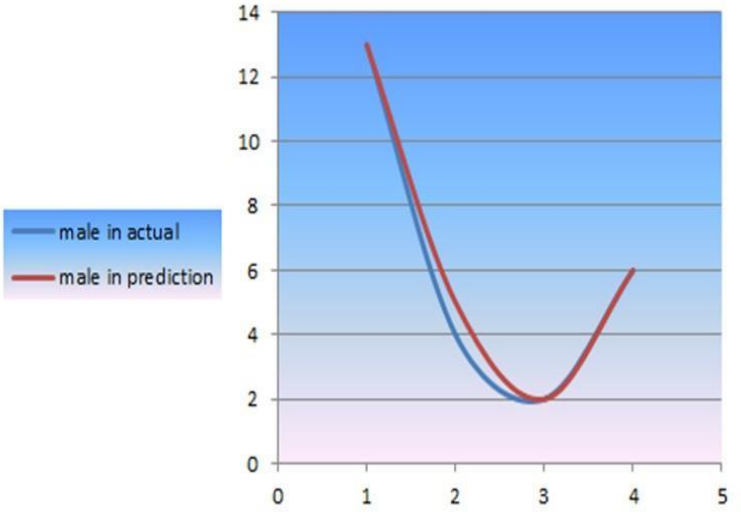


**Fig. (5.2) Number of males in myocardial infarction.**

The actual results of no. of males in first four months are 13,4,2and 6 respectively, while the predictive results 13,5,2 and 6.

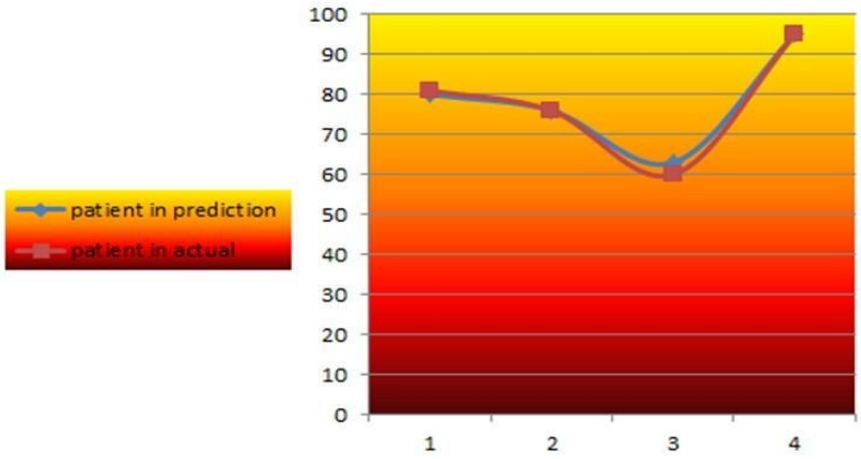


**Fig. (5.3) no. of patients in angina.**

This image of number of heart patients for angina for four months, the orange line is for actual results, the y-axis is for patient's number and x-axis is for months, The blue line is for predictive results. The actual results are 81, 76, 60 and 95 respectively. The predictive results are 80, 76, 63 and 95 for first four month respectively.

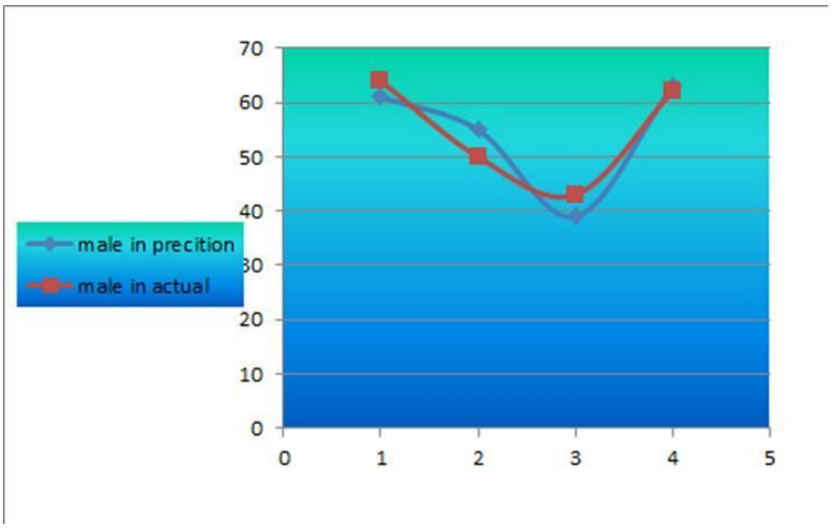


**Fig. (5.4) the no. of males in angina.**

The actual results of no. of males in angina disease for the four months are 64, 50, 43 and 62 respectively. The predictive results are 61, 55, 39 and 62.

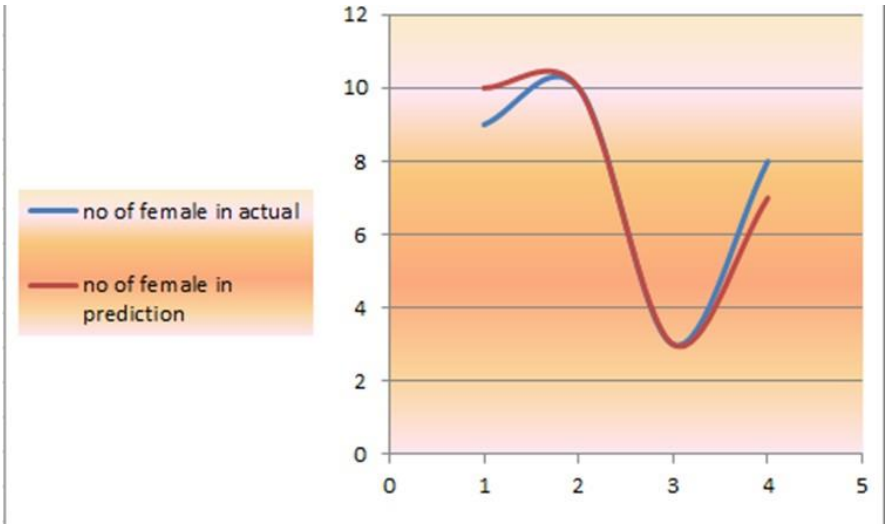


**Fig. (5.5) no. of females in high blood pressure disease.**

This image of number of females in high blood pressure disease the blue line is for actual results, the red line is for predictive results. The y-axis is for patient's number and x-axis is for months. The actual results for the four months are 9, 10, 3 and 8 respectively while the predictive results are 10, 10, 3 and 7.

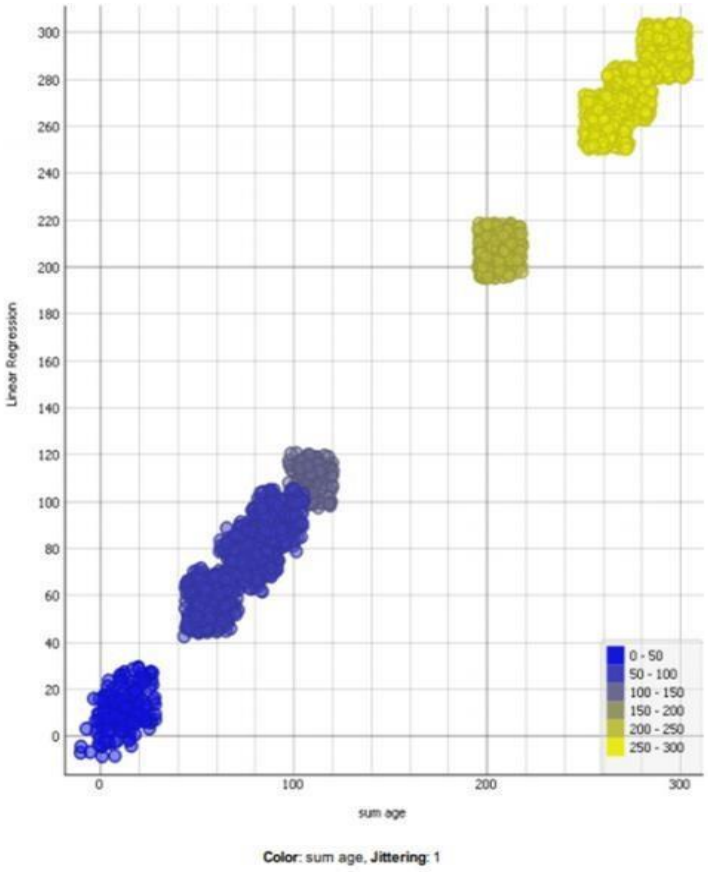


**Fig. (5.6) distribution of sum age.**

Sum age between(10-25) the no. of patients is 35, ages between( 40-60) the no. of patients is 85, sum age between(85- 110) the no of patients is 110, sum age(110-150) no of patients is 120, sun age between(150-200) the no. of patients is 200, sum age between(200-250) no. of patients is 220 and sum age between(250-300) is 300.

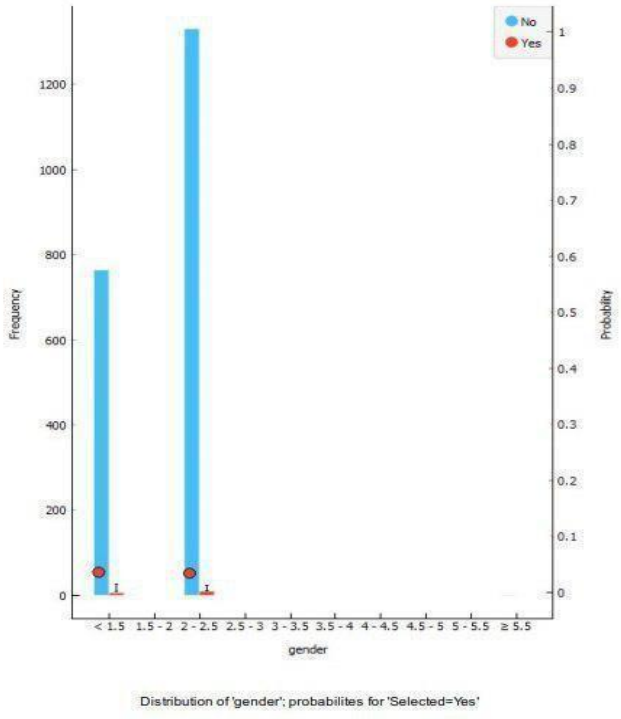


**Fig. (5.7) distribution probabilities for gender.**

Female's range (0-1.5), The probability of female heart diseases is (0.5-0.6)

Male's range (1.5-2.5), the probabilities of female is less than male of heart diseases.

## Discussion

After data were entered for the first four months of 2017 for the orange program and select linear regression and random forests models, after the introduction of the ten diseases data, results were obtained for the first four months of 2018. Three random diseases were selected to show their results, such as disease number 3(myocardial infarction), the actual number of patients for the first month of 2017 was 22, 6, 3and 8 respectively. The prediction results are 21, 7, 3 and 8. The number of males patients for the actual first four months was 13, 4, 2 and 6 respectively, and the predictive results for the first four months of 2018 will be as follows: 13, 5, 2 and

The second disease is disease number 5(angina), the actual results of the number of patients for the first four months respectively81,76 ,60 and 95, and the predictive results for 2018 are80,76 ,63 and 95. The number of males for the actual results of the four months was 64, 50, 43and 62, and the predictive results for first four month of 2018 are 61, 55, 39 and 63 respectively

The third disease is the disease of high blood pressure, the actual number of patients for four months is 12,15,7 and 12 and the number of patients predicting the first four months in 2018 is 17, 15, 6 and 11. The number of female patients for the first four months of the actual results respectively 9, 10, 3 and 8 and predictive results .10, 10, 3 and 7.

In general, these 10 heart diseases have been found to be the most common male patients. For example, coronary artery disease, the total number of patients is 1045, the number of males is 659 and the number of females is 386. However, the number of female patients with anemia is higher than that of males. The number of female patients is 18 and the number of male patients is 5 in four months. As is the case of hypertension, the number of females in the four months is 31 and the number of males is 19. But the average age of females is higher than that of males. For example, in coronary artery disease, the average age of females is 60 years while the average age of males is 55 years. The results were very close to the actual results that prove the system we use is effective.

## Conclusion

Heart diseases are very dangerous and we must treat patients with caution especially before the operation, through the preparation of medicine, medical supplies and medical staff, before the patient comes to the hospital. So not to waste any time because one second may affect patients safety this gets through taking data from previous years and analyzing them and using one model of the neural network methods to predict, all in order to preserve the patient's life.

## Future work

In the future, we hope to have more data. More data means more accurate results. And we can predict the number of doctors and nurses every operation need.

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***الخلاصة من المشروع***

**القلب** هو اكثر عضو حيوي في جسم الانسان واذا كان هنالك أي مرض بالقلب فان كل اعضاء الجسم سوف تتأثر به او ممكن ان يتسبب بالموت, وبسبب ان معظم وفيات العالم تحدث بسبب امراض القلب يجب الاهتمام والاعتناء بمرضى القلب من خلال تزويدهم بالدواء والكادر الطبي والتجهيزات الطبية التي يحتاجونها قبل العملية. الفكرة من المشروع هو التنبؤ بأمراض القلب باستخدام تقنيات الذكاء الاصطناعي من خلال التنبؤ بعدد وتاريخ وجنس ونوع المريض الذي يعاني من امراض القلب الذي لا اقل ولا تكفي الحاجة ولا كمية اكثر وتصبح منتهية الصلاحية كمية دواء مناسبه للمستشفى لاحقا. وايضا جلب سوف يأتي.