Advanced Optimization tool for the Heart Patient

Jossy P. George, Tessy Tom, Suhas M. Gaikwad

Abstract*: Coronary Angiography bypass sugary is meant for removing blockage in the coronary arteries of heart. Removing blockage from the heart with Coronary Angiography leads to the regulation of the blood flow rate at normal pressure. However, after a few years of the Coronary Angiography bypass sugary nearly fifty percent of people will develop again a blockage in the coronary arteries. Although, the Medical Science and Technology advanced so much there is a lack of an Optimization tool that handles complications of the Coronary Angiography bypass sugary. A new Optimization tool using Genetic Algorithm with the Coronary Angiography bypass sugary GA-CABAG, and Cohort Intelligence, Coronary Angiography bypass surgery CI –CABAG is introduced to help to resolve the above-mentioned problem.

Keywords*: : Optimization, Heart Patient, Genetic Algorithm, Cohort Intelligence, GA-CABAG, CI-CABAG, Image Processing

I. INTRODUCTION

Here follows further instructions for authors. Coronary Angiography is a technique used for detecting blockages in the heart. In Coronary Angiography a combination of X-ray and a special dye is used [1, 2] for testing the blood flow through the heart [3, 4]. Coronary Angiography is done with the cardiac catheterization [5, 6]. The cardiac catheterization is a procedure to measure the blood pressure in a heart chamber [7, 8]. During cardiac catheterization, a thin hollow tube known as catheter is inserted into an artery or vein in groin, neck, or arm and is threaded through blood vessel until it reaches the heart**.** Once the catheter is in place [9, 10], a contraceptive dye is inserted into the catheter and X-ray images are taken to run the diagnostic tests [11, 12]. The dye helps to highlight the blockages in the arteries [13, 14] and Coronary Angiography bypass sugary is done on the patient to remove these blockages [15, 16]. But it is observed that in the next 5 years of span, 20 percent of the patients have an occurrence of blockage again in their heart. While in the next 10 years 50 percent of the patients will again come for the Coronary Angiography bypass sugary [17, 18]. Although Medical Science and Technologies development in transitional research domain has advanced so much, this problem of Coronary Angiography, bypass sugary is still continuing[19, 20].

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However, there is no technique available to predict whether the patient is having a tendency for the reoccurring of blockage once the Coronary Angiography is done. The optimization tool introduced here uses the Genetic algorithm along with cohort intelligence with respect to image processing. The algorithm working in this optimization domain will produce results of great accuracy in predicting.

II. LITERATURE SURVEY

The research article "Cohort Intelligence and Genetic Algorithm Along with AHP to Recommend an Ice Cream to a Diabetic Patient" uses an optimization technique. Analytical Hierarchy Process is a mathematical modeling to solve complex mathematical problems. And for The optimization, the Genetic Algorithm and cohort Intelligence [23, 24] are used for recommending an ice cream to a diabetic patient based on the sugar content in it. Analytical Hera key process is used for assigning the weight and criteria. Criteria considered are Sugar, Fats, Dietary Fiber and weights are assigned to it manually. Similarly, for Diabetic patients weights are assigned. A couple of equations proposed to link Analytical Hera key process to Genetic Algorithm [25, 26]. A good example in the domain of Transitional research domain is demonstrated in the above-mentioned article. Denny, in his article "Genetic Algorithm for Solving Simple Mathematical Equality Problem explained "how the Genetic Algorithm is work in optimizing. The article briefs about different stages of the algorithm -selection, evolution, crossover, and mutation. The calculation involved in these stages are explained with a mathematical example [27, 28]. S.M.Limb referred in the article "Crossover and Mutation Operators of Genetic Algorithms", about the use of crossover and mutation operator. The operators like crossover and mutation in Genetic Algorithm should be efficiently used to get the best optimal result. Cohort Intelligence algorithm is a very useful technique in optimization related problems. In Cohort Intelligence, the first step is the selection of candidate. The selection of candidate is based on pointing out the best candidate with the most variation The variation refers to the changes shown by the individual of a species and also by offspring's of the same parents [29, 30]. Forming a group of candidates with maximum variation is done, the same procedure is applied for every group for finding the other candidates

2.1] Organization

The introduction of Coronary Angiography bypass sugary given in section 1. Architectonics of optimization for GA-CABAG and CI-CABAG containing Genetic Algorithm and Cohort Intelligence is a working principle for optimization with respect to Coronary Angiography bypass sugary elaborated in Section 3.

Section 4 includes the result set of Advance Algorithm GA-CABAG also CI-CABAG for Heart patient obtained and section 5 concludes the work of optimization phenomenon with Coronary Angiography bypass sugary.

III. 3] ARCHITECTONICS OF OPTIMIZATION FOR CORONARY ARTERIES BYPASS SURGERY

This Optimization domain is useful to obtain the best results for Coronary Angiography problem, [21, 22] as it gives the best suitable value for the given problem under consideration. [23, 24]. This Optimization procedure uses two different techniques namely, Genetic Algorithm. and Cohort Intelligence algorithm. The problem considered is here from the Coronary Angiography domain. To solve the problem related to Coronary Angiography with Coronary arteries bypass surgery using the G.A. approach, a set of equations that supports G.A. to provide an optimum solution for Coronary Angiography needs to be proposed

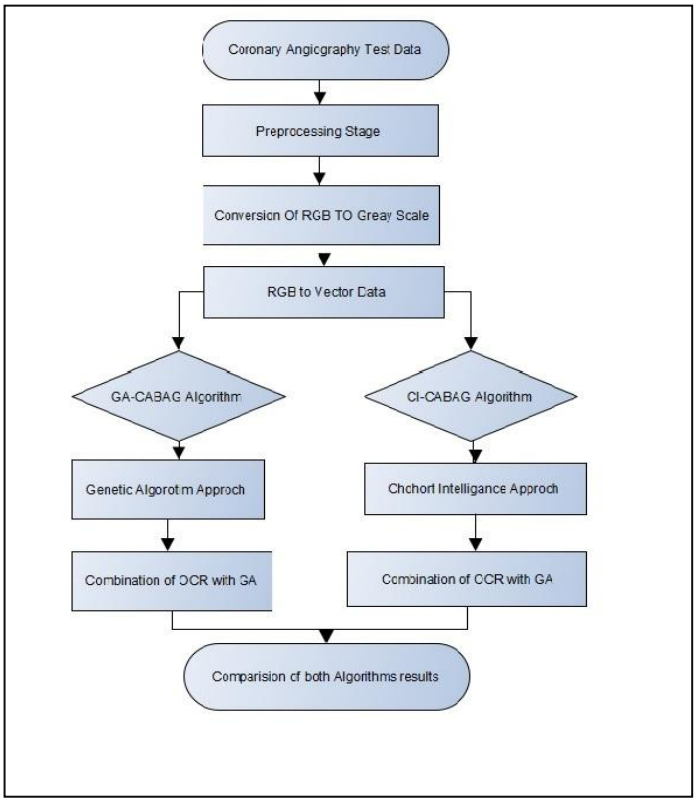


Fig 1- Flowchart of optimization for Coronary

Figure-1 represents the state diagram of the optimization model for the Coronary arteries bypass surgery. For classification purpose the dataset of the coronary arteriography test data [25, 26], is considered [27, 28]. Again for Coronary Angiography bypass surgery Medical image data is considered. Coronary arteries bypass image has been converted into grayscale. For GA-CABAG, algorithm optimization function is given as the input in grayscale Also the same greyscale input is given to the advanced algorithm CI-CABAG [29]. Optimization results are obtained by comparing GA-CABAG and CI-CABAG obtained for the input Medical image.

3.1] The mathematical formulation of the equation for the blood flow in the coronary arteries

The equation for blood flow in coronary arteries can be formulated as.

Blood flow = ΔP/ Resistance

$$= 8 \pi \Delta P r^4 \eta \lambda$$

- ΔP represents the difference in pressure.
- r^4 is the radius (one-half of the diameter) of the vessel to the fourth power.
- η represents the viscosity of the blood.
- Λ represents the length of a blood vessel.

Implies

Resistance = ΔP/ Blood flow

Then by substituting Ponselle's equation for blood flow:

Resistance = $8\eta\lambda/\pi r^4$

ΔP= Blood flow * Resistance

$= (8 \pi r^4 \eta\lambda) * (8 \eta \lambda /\pi r^4)$

3.2] Craft ship for Genetic Algorithm with Coronary Angiography Bypass Surgery (G.A. – CABAG)

For the Coronary Angiography problem, an image is taken into consideration for identifying a heart blockage. And this image is converted into the vector form of data. Since the converted data is in number format the data, manipulation becomes easier. To work with G.A. some set of equations is needed to propose with respect to Coronary Angiography.

Function Y= GA-CABAG(x)

Y (1) =0.2126*x (1) +0.7152*x (1) +0.0722*x (1) + (π r48$\eta\lambda$) * (8 $\eta \lambda /\pi$r4); [1]

End

Equation [1] represents the coefficients for various colors- the red, green and blue for the image under consideration. Human naked eyes are sensitive to green color and its value 0.7152 is greater compared to red and blue. While eyes are less, sensitive to the blue color so its value 0.0722 is the smallest. The last coefficient is for red color represented by a value of 0.2126. For each generation best possible optimum value is obtained. Moreover, G.A. is progressed through either a 50th generation or a 100th generation until the best optimum value for the given set of image is reached. Finally, G.A. will be terminated automatically after reaching the optimum value for a given image. All the optimum values for an image are given in table (1).

3.3] Craft ship for Cohort Intelligence with Coronary Angiography Bypass Surgery (C.I. – CABAG)

As suggested in G.A.-CABAG algorithm, a similar kind of approach is applied for the image of Coronary Angiography. Moreover, to work on any image data given image should converted into the vector form. Image is converted into vector form with the help of a grayscale image. So that the given image is in vector form.

Cohort Intelligence (C.I.) is an optimization algorithm. To link C.I. with Coronary Angiography a certain set of equations are proposed.
For i=1:50

$$Y(i) = 0.299.*a + 0.587.*b + 0.11.*c + (\pi r^4 8\eta\lambda) * (8\eta\lambda/\pi r^4); \quad [2]$$

$$X(i) = 0.2126.*d + 0.7152.*e + 0.0722.*f + (\pi r^4 8\eta\lambda) * (8\eta\lambda/\pi r^4); \quad [3]$$

$$Z(i) = 0.2126.*j + 0.6780.*h + 0.0593.*w + (\pi r^4 8\eta\lambda) * (8\eta\lambda/\pi r^4); \quad [4]$$

% Fitness function % [5]

k (i) =1/y (i);

g (i) =1/x (i);

l (i) =1/z (i);

% Total Fitness function % [6]

T (i) =k (i) +g (i);

% Probability %

p (i) = k (i)/T (i);

q (i) =g (i)/T (i);

r (i) =l (i)/T (i);

% Roulette Wheel Approach % [7]

R (i) = P (i) +q (i);

% Replacement of Candidate % [8]

aj (i) =y (i);

bj (i) =x (i);

cj (i) =z (i);

Y (i) =cj (i);

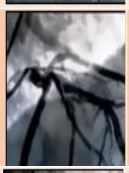
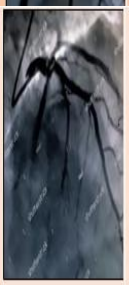
X (i) =aj (i);

Z (i) =bj (i);

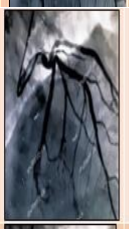
End

The proposed set of equations can be expressed in different forms as described by equations [2, 3, and 4]. Let a, b, c represent the unknowns. The values of three unknowns (a, b, c) can be evaluated using the three equations [2, 3, and 4]. After finding the values of the unknowns, it is time to calculate the fitness function. Equation [5] represents the fitness function. Now the total of fitness, represented by equation number [6] and the probability value [7] should be calculated [7]. In roulette, wheel approach replacement of candidate is represented by equation [7, 8]. So same procedure can be repeated for the next generation, and it

Table -1 Optimization used for CABAG

Number of the patient for coronary arteriograp hy Test	coronary arteriography Test for coronary artery bypass grafting	GA-CABAG Objective function value AT 102 Generation	CI-CABAG Cohort Intelligence at 50th Iteration	CI-CABAG Cohort Intelligence at 200th Iteration	Time Complexity of C.I. at 50th /200th Iteration in sec
1		0.36218	0.58699	0.58699	0.017 / 0.014
2		0.35881	0.58718	0.58718	0.017 / 0.014
3		0.35552	0.59253	0.59253	0.017 / 0.014
4		0.36728	0.58747	0.58747	0.017 / 0.014
5		0.34928	0.59280	0.59280	0.017 / 0.014
6		0.360791	0.59594	0.59594	0.017 / 0.014

IV. 4] RESULT SET FOR OPTIMIZATION USED FOR CORONARY ARTERIES BYPASS SURGERY

7		0.35773	0.58948	0.58948	0.017 / 0.014
8		0.35174	0.58524	0.58524	0.017 / 0.014
9		0.36259	0.59283	0.59283	0.017 / 0.014
10		0.359616	0.58676	0.58676	0.017 / 0.014
11		0.35673	0.59264	0.59264	0.017 / 0.014
12		0.35393	0.59447	0.59447	0.017 / 0.014
13		0.36424	0.588620	0.58862	0.017 / 0.014
14		0.35858	0.58704	0.58704	0.017 / 0.014
15		0.3559	0.59033	0.59033	0.017 / 0.014
16		0.36562	0.58481	0.58481	0.017 / 0.014
17		0.36291	0.58793	0.58793	0.017 / 0.014
18		0.36026	0.59325	0.59325	0.017 / 0.014
19		0.35779	0.59202	0.59202	0.017 / 0.014

20		0.35521	0.59309	0.59309	0.017 / 0.014

Results set contains table number 1 including figure 1 of patient image for the left heart. Figure 1 shows for coronary angiography test output for patient number 1. Although applying new G.A.-CABAG Algorithm for the best optimization result obtained at 102nd iteration. Thus, the value obtained is in the range of 0.36218. Similarly, for C.I. -CABAG Algorithm best optimization results produced at 50^{th} and 200^{th} iteration are 0.58699. With time, complexity is 0.017 and 0.014 for 50^{th} and 200^{th} iteration value. Similarly, for patient number 1 to patient number 20 the Coronary Angiography test done and display the figure in table numer-1. In addition, the optimization tool like GA-CABAG gives best optimization value within the range of 0.34-0.36. While CI-CABAG best optimization 0.58-0.59 for 50^{th} and 200^{th} iteration value.

V. CONCLUSION

Optimization tool provides an optimum solution for Coronary Angiography regarding of heart blockage evaluation. An optimization technique is always useful for solving a real-life problem. Thus, the problem is with respect to the Coronary Angiography bypass sugary. Linking of Coronary Angiography bypass sugary problem with optimization is an easy task. Hence, optimization is always a useful tool for the classification of the image of Coronary Angiography. Similarly, for the Coronary Angiography problem of recognizing the heart blockage solved more precisely with the optimization tool. In addition, Coronary Angiography with optimization helps in reducing the reoccurrence of heart blockage. However, the use of the Optimization tool for Coronary Angiography works for finding out and reducing the reoccurrence of heart blockage.

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