Genetic Posting of Security Personnel (GPSP) in a Campus Setting

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ABSTRACT

The allocation of security personnel to duty posts in a university may affect the efficiency of the security personnel and the overall efficiency of the security unit. This may have serious implications for the security of individuals and the organization. The manual mode, which is a conventional method adopted in posting security personnel in most universities focuses more on physical ability but less on emotional intelligence. Previous researches have shown that security job is emotionally demanding. Emotional intelligence may play a key role in the way an individual reacts to and manages emotional information of self and others. This study therefore introduces a system of posting security personnel that takes emotional intelligence as a key determinant factor in the posting of security personnel. Specifically, this study introduces an artificial intelligence heuristic method of allocation (genetic algorithm) for the scheduling of security officers with respect to their emotional intelligence. The system takes inputs such as emotional characteristics of the officers, quantifies it, and matches it with the criticality or otherwise of the units to be posted to. The new method is very important because the university security department is an important section of a campus setup, as any loop hole in this area might be very disastrous. It is made up of different units such as intelligence, crime, traffic, fire safety etc. Each of these units has unique features that distinguish it from another; therefore, for any officer to work effectively in the duty post, he must be configured with the right level of emotional intelligence.

KEYWORDS

heuristic, emotional, artificial, intelligence, security, posting, allocation, university, campus

1. INTRODUCTION

Security as described by the institute for security open methodologies (ISECOM, 2000) is a form of protection where a separation is created between the assets and the threat, these separations are generically called controls and sometimes include changes to the asset or the threat (Herzog, 2000). It can also be viewed as a degree of resistance to, or protection from, harm, it applies to any vulnerable or valuable asset, such as a person, dwelling, community, item, nation or organization (Herzog, 2000). Security risks are on the rise and it is so unfortunate that many organizations do not have the necessary office security measures in place to help protect their premises and assets from possible threats.

Security is one of most important issue that must considered before setting up any organization, as failure to do this may lead to unwanted activities such theft, vandalism, sabotage, unauthorized access, violence etc. Using a university as a case study, there are several strategic locations, if not all, in a campus where security is of high priority, as protection of life of students and staffs and well as the infrastructures being put in place to ensure the proper flow of activities in the university must be ensured.

This study is centered on how allocation of security officers to different sections of the university can be done by combining several variables such as physical characteristics and emotional competencies of officers to determine the fitness and the appropriate section of an organization that an officer will be posted to, doing this will aid in quick allocation of officers. Artificial intelligence methods shall be used to set up a fitness function which will be further defined over the genetic representation to measure the quality of the presented solution. The encouragement of use of this method will be a perfect substitution for the previous methods (manual) employed by various security companies.

2. METHODOLOGY

To satisfy the objectives of this research, the following approach was used.

Phase 1 (Data collection): Interview of experts in the field of psychology and security unit in the university shall be carried out to gather data on physical and emotional characteristics of security officers.

Phase 2 (Data analysis): content analysis will be used to analyze the data which was gathered from personal interview to help reduce and simplify the data collected and convert to a form that can be measured using quantitative techniques.

Phase 3 (System development): After critical evaluation of data has been done, Artificial intelligence methods and suitable programming language such as Java or visual basic.Net will be deployed to develop the proposed system.

Figure 1: Study Procedures

3. ARCHITECTURAL DESIGN

The following models were deployed as guide in the implementation of this research work. These include, the data flow diagram and use case diagram

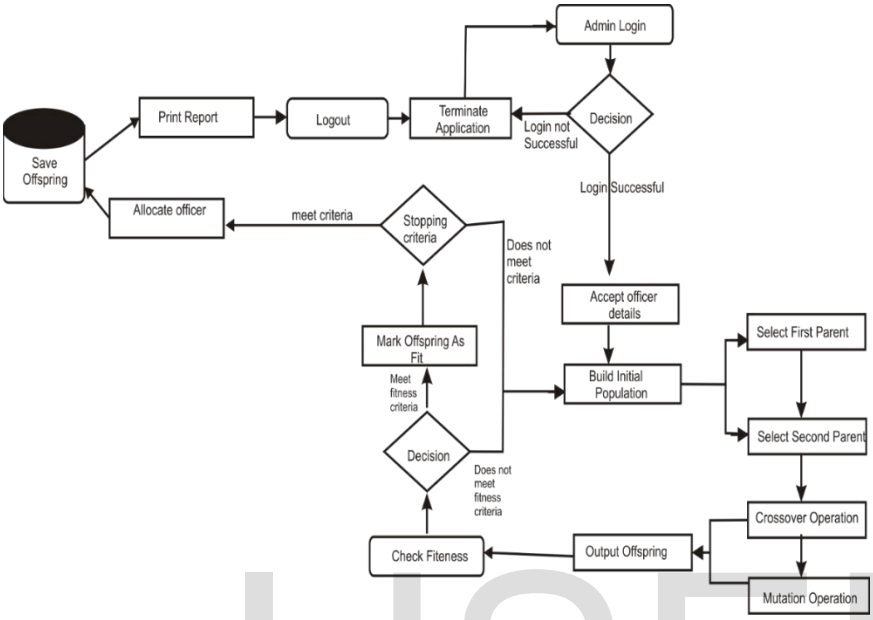

Figure 2: Data Flow of the research work

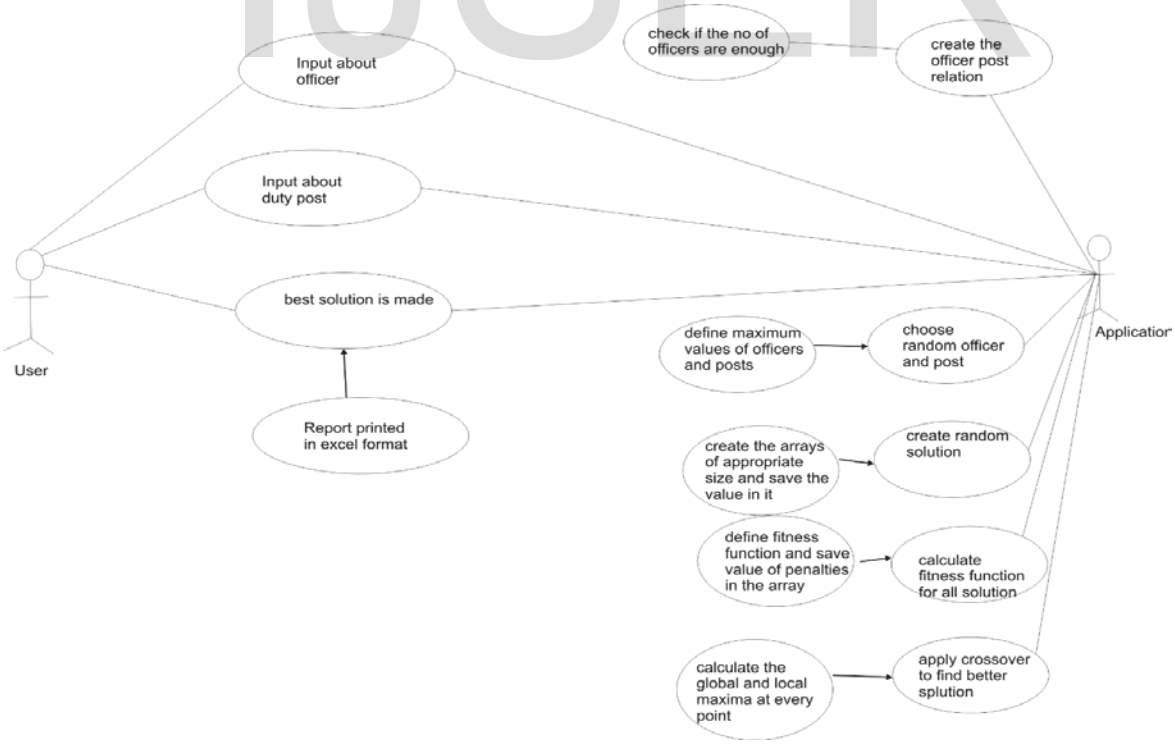

Figure 3: Proposed Use case model

4 DESIGN AND IMPLEMENTATION

4.1 SYSTEM DESIGN

Systems design is the process of defining elements of a system like modules, architecture, components and their interfaces and data for a system based on the specified requirements (https://economictimes.indiatimes.com/definition/systems-design). It is the process of defining, developing and designing systems which satisfies the specific needs and requirements of a business or organization. As earlier stated in the previous chapter, genetic algorithm approach will be employed in the design of the proposed system.

Genetic Algorithm

Genetic Algorithm (GAs) are search methods based on principle of natural selection and genetics (Fraser, 1957). We start with a brief introduction to simple genetic algorithms and associated technology. GAs encodes the decision variables of a search problem into finite-length strings of alphabets of certain cardinality, GAs work with coding parameters themselves. To evolve good solutions and to implement natural selection. We need a measure for distinguishing good solutions from bad solutions. The steps involved in the development of the system through genetic algorithm include:

Step 1: Produce an initial population of individuals

Step 2: Evaluate the fitness all the individuals

Step 3: While termination condition not met **do**

Select fitter individuals for reproduction

- Recombine between individuals
- Mutate individuate
- Evaluate the fitness of the modified individuals
- Generate a new population

End while

Building initial population

An initial population of officers with their emotional fitness will be selected at this stage. This is done by randomly selecting randomly from officers whose detail has been recorded into the system database.

Genetic Operators

Basically, there are three basic genetic operators in genetic algorithm, they are:

1. Selection
2. Cross Over
3. Mutation

Selection

Selection is the first genetic operation in the reproductive phase of genetic algorithm. Its purpose is to choose the fitter individuals in the population that will create off-springs for next generation, commonly known as mating pool. The mating pool thus selected takes part in further genetic operations, advancing the population to the next generation and hopefully close to the optimal solution. Selection of individuals in the population is fitness dependent and is done using different algorithms. Selection chooses more fit individuals in analogy to Darwin's theory of evolution – survival of fittest

Forms of Selection

1. Roulette wheel selection
2. Rank Selection
3. Tournament selection

Roulette Wheel Selection

Roulette wheel is the simplest selection approach. In this method all the chromosomes (individuals) in the population are placed on the roulette wheel according to their fitness value. Each individual is assigned a segment of roulette wheel. The size of each segment in the roulette wheel is proportional to the value of the fitness of the individual - the bigger the value is, the larger the segment is. Then, the virtual roulette wheel is spinned. The individual corresponding to the segment on which roulette wheel stops are then selected. The process is repeated until the desired number of individuals is selected. Individuals with higher fitness have more probability of selection. This may lead to biased selection towards high fitness individuals.

$$\overline{\mathrm{FRW_{ij}}} = \frac{\sum_{j=1}^{n} FRW}{N}$$

where i varies from 1 to ngen and j varies from 1 to N. Therefore, the probability for selecting the jth string is

$$PRW_j = \frac{FRW}{\sum_{j=i}^{N} FRW}$$

where N is the population size and FRWjis the fitness of individual j.

Notations

N → total population size

———

FRW → Average Fitness of the population in all generations in Roulette Wheel Selection

FRWi,j → fitness of jth individual in ith generation for roulette wheel selection

ri,j → rank of jth individual in ith generation for rank selection

rsumi → sum of ranks in ith generation

ngen → total number of generations

mpool → number of chromosomes in mating pool

Roulette wheel selection algorithm

1. Set l=1, j=1, i=nogen
2. While l <= mpool

Begin

a) While j<=N

Begin

Compute FRWi,j

End

b) Set j=1, S=0

c) While j<=N

Begin

Compute S=S+FRWi,j

End

d) Generate random number r from interval (0,S)

e) Set j=1, S=0

f) While j<=N

Begin

Calculate cj=cj-1+FRWi,j

If r<=cj, Select the individual j

End

g) l=l+1

End

Rank Selection

Rank selection sorts the population first according to fitness value and ranks them. Then every chromosome is allocated selection probability with respect to its rank. Individuals are selected as per their selection probability. Rank selection is an explorative technique of selection. Rank selection prevents too quick convergence and differs from roulette wheel selection in terms of selection pressure. Rank selection overcomes the scaling problems like stagnation or premature convergence. Ranking controls selective

pressure by uniform method of scaling across the population. Rank selection behaves in a more robust manner than other methods. In Rank Selection, sum of ranks is computed and then selection probability of each individual is computed as under:

$rsum_i = \sum_{i=1}^{N} r_{ij}$

where i varies from 1 to ngen and j varies from 1 to N.

$PRANK_i = \frac{r_{i,j}}{rsum_i}$

Algorithm for Rank Selection

```
NewFitness=sort(Fitness);
NewPop=round(rand(PopLength,IndLength));
for i=1:PopLength
   for j=1:PopLength
      if(NewFitness(i)==Fitness(j))
         NewPop(i,1:IndLength)=CurrentPop(j,1:IndLength);
         break;
      end
   end
end
CurrentPop=NewPop;
ProbSelection=zeros(PopLength,1);
CumProb=zeros(PopLength,1);
for i=1:PopLength
   ProbSelection(i)=i/PopLength;
   if i==1
      CumProb(i)=ProbSelection(i);
   else
      CumProb(i)=CumProb(i-1)+ProbSelection(i);
   end
end
SelectInd=rand(PopLength,1);
for i=1:PopLength
   flag=0;
   for j=1:PopLength
      if(CumProb(j)<SelectInd(i) && CumProb(j+1)>=SelectInd(i))
```

```
            SelectedPop(i,1:IndLength)=CurrentPop(j+1,1:IndLength);
            flag=1;
            break;
        end
    end
    if(flag==0)
        SelectedPop(i,1:IndLength)=CurrentPop(1,1:IndLength);
    end
end
```

Notations

IndLength = Individual length

SelectedPop = selected population

CurrentPop=current population

CumProb = cumulative probability

ProbSelection=probability of selection

NewPop = new population

SelectInd = select individual

Tournament Selection

Tournament selection is probably the most popular selection method in genetic algorithm due to its efficiency and simple implementation. In tournament selection, n individuals are selected randomly from the larger population, and the selected individuals compete against each other. The individual with the highest fitness wins and will be included as one of the next generation population. The number of individuals competing in each tournament is referred to as tournament size, commonly set to 2 (also called binary tournament). Tournament selection also gives a chance to all individuals to be selected and thus it preserves diversity, although keeping diversity may degrade the convergence speed. The tournament selection has several advantages which include efficient time complexity, especially if implemented in parallel, low susceptibility to takeover by dominant individuals, and no requirement for fitness scaling or sorting.

Algorithm for tournament selection

```
Function tournament_selection (population, k):
Best = null
For i=1 to k
        Individual = population [1, N]
        If (best == null) or fitness (individual) > fitness
```

Best = individual

Return best

For purpose of this research work, tournament selection method will be adopted because it has several benefits over alternative methods for genetic algorithm, it is efficient to code, works on parallel architectures and allows the selection pressure to be easily adjusted. Tournament selection has also been shown to be independent of the scaling of the genetic algorithm fitness function in some classifier systems.

Cross over

The crossover operator is an analogous to reproduction and biological crossover, more than one parent is selected, and one or more off-springs are produced using the genetic materials of the parents. It is usually the first operator applied in population. Chromosomes are selected from the population of parents to cross over and produce offspring. It is based on Darwin's evolution theory of 'Survival of the fittest'. Therefore, this operator is also known as reproduction. For each new solution to be produced, a pair of 'parent' solutions are selected for breeding from the pool selected previously. By producing a 'child' solution using the above methods.

Forms of cross over operation

1. One Point crossover
2. Multi Point Crossover
3. Uniform crossover

One-point crossover

Here, random crossover point is selected and tails of its two parents are swapped to get new off-springs.

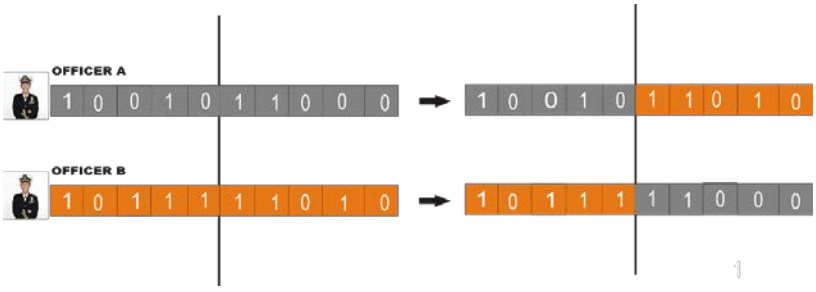

Figure 4: One-point crossover

Uniform crossover

Here, we do not divide the chromosome into segments, rather we treat each gene separately. In this, we essentially flip a coin for each chromosome to decide whether or not it will be included in the off-spring. We can also bias the coin to one parent, to have more genetic material in the child from that parent.

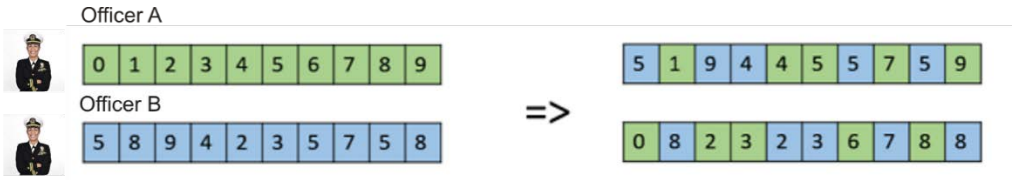

Figure 5: Uniform crossover

Multi point Crossover

Multi point crossover is a generalization of the one-point crossover wherein alternating segments are swapped to get new off-springs.

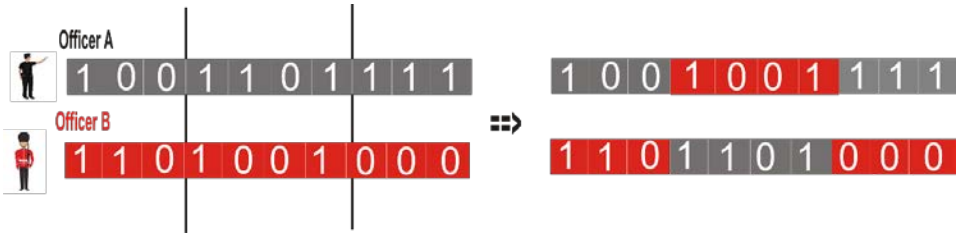

Figure 6: Multipoint operation

For the purpose of this project, the multipoint crossover method will be considered because it gives room for a wider range of manipulating the genes of the chromosomes.

Mutation

Mutation is a genetic operator that can be used to maintain genetic diversity from one generation of a population of genetic algorithm chromosome to the other. Mutation represents a change in the gene, it is role is to provide a guarantee that the search algorithm is not trapped on a local optimum. The mutation operator flips a randomly selected gene in a chromosome. This probability is to be set low, else if it is too high, the search will turn into a primitive random search. It typically ranges between 0.001 to 0.01.

Here, we shall consider two types

1. Bit Flip Mutation
2. Swap Mutation

Bit flip Mutation

In this bit flip mutation, we select one or more random bits and flip them. This is used for binary encoded GAs.

Figure 7: Bit flip mutation

Swap Mutation

Here, we select two positions on the chromosome at random, and interchange the values. This is common in permutation-based encodings.

Figure 8: Swap mutation

For this research work, flip mutation will be considered.

Termination criteria/condition

This generational process is repeated until a termination condition has been reaches. Common termination conditions are:

1. A solution is found that satisfy minimum criteria
2. Fixed number of generation reached
3. Allocated budget reached
4. The highest-ranking solutions fitness is reaching or has reached a point such that successive iterations no longer produce better results

INTERFACE DESIGN

Below is the design of the system

Figure 9: The setup Interface

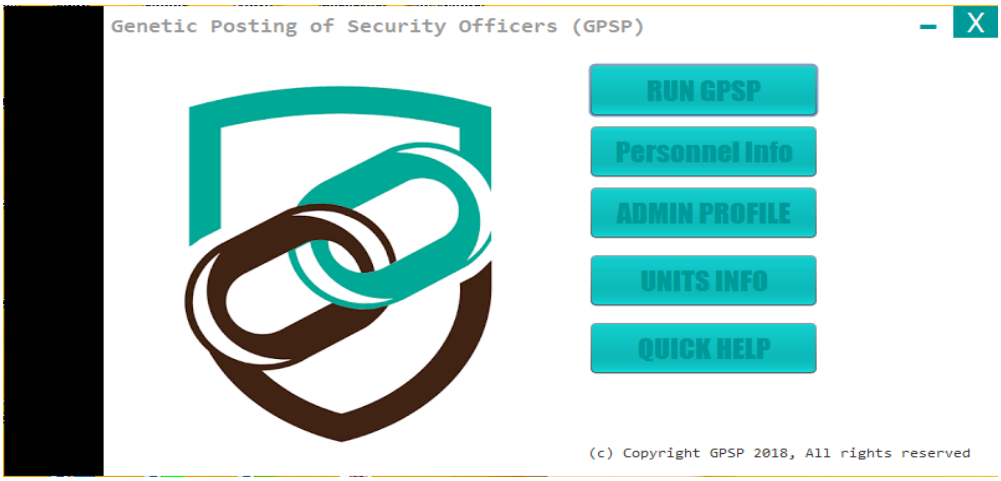

Figure 10: Main interface

OPERATIONAL INTERFACE

The genetic algorithm run interface

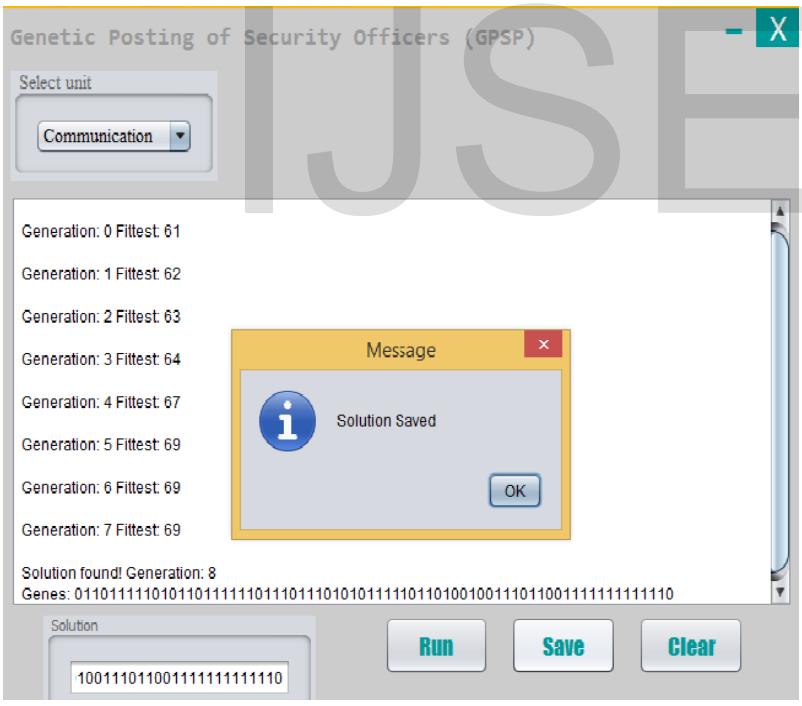

Figure 11: The GA run interface

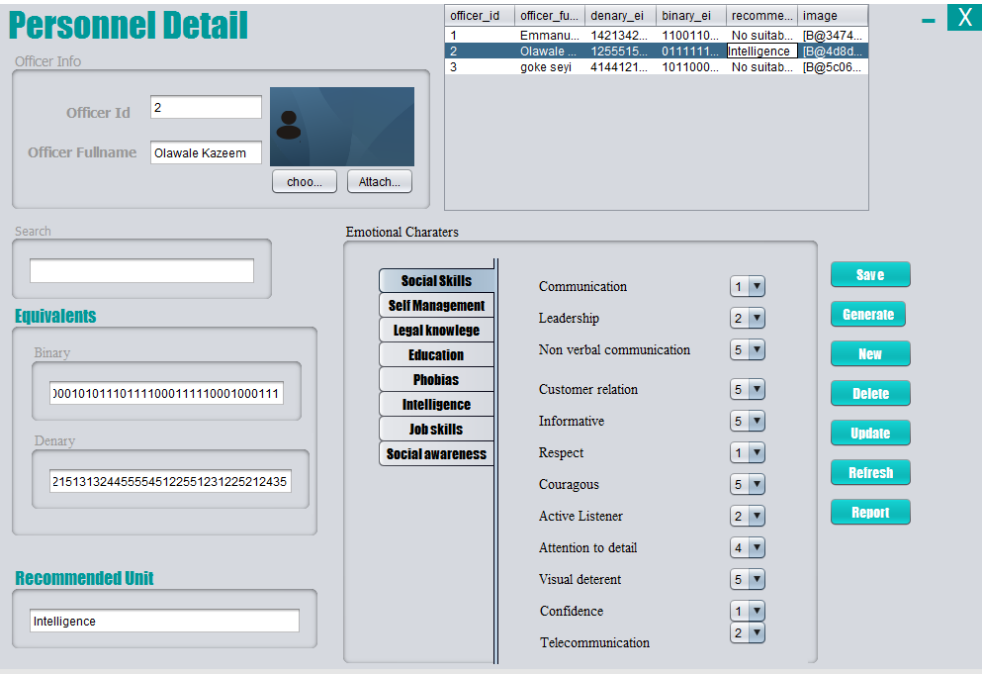

Figure 12: The officer profile window

4.2 PROGRAMMING LANGUAGE SPECIFICATION

Java was made the choice of the programming language due to its object-oriented feature, that is, it supports the construction of collaborating objects. Java is simple and highly robust, it is also designed to be secured in a networked environment. Due to the its portability nature, Java ensures that other implementation-dependent aspects of language specification is eliminated.

4.3 DATABASE SPECIFICATION

MySQL database used as the database due to some of its features which include high security, portability, free, robustness and simplicity.

4.4 IMPLEMENTATION APPROACH

The implementation approach adopted for this study is Agile Development model. Agile development model is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product. It breaks the product into small incremental builds. These builds are provided in iterations.

Out of all the various forms of agile development model, this study specifically adopted the feature driven development model (FDD) because it suits the purpose of this system.

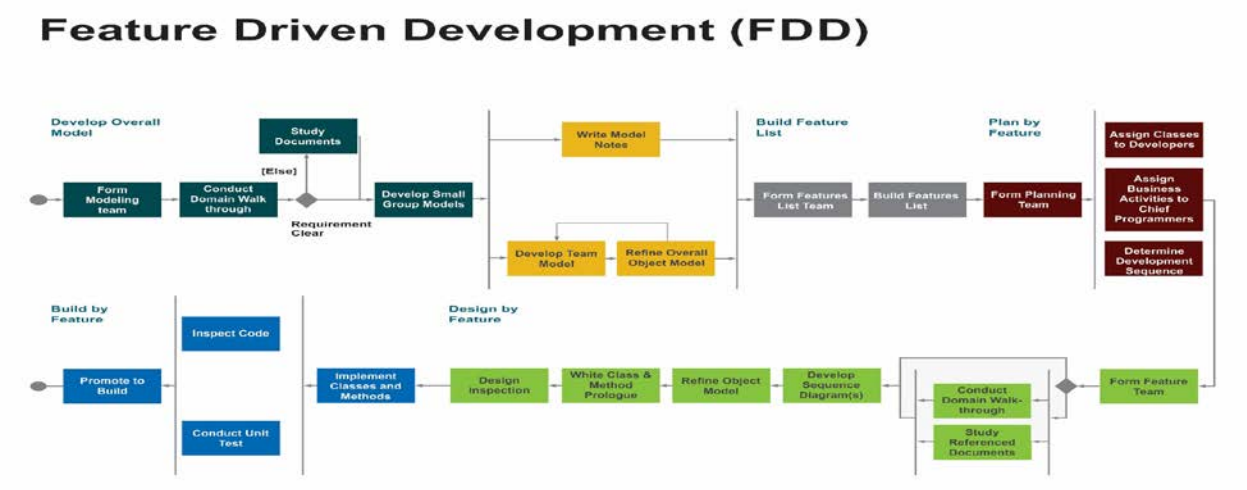

Figure 15: Feature driven development model

5. CONCLUSIONS

Various heuristic search approach has been used over the years for the scheduling and allocation of resources. The approach employed in this study is genetic algorithm, and it has so far been able to prove to be not just an intelligence approach but also a better approach when compared to some its counterparts. Through this approach, we were able to develop a system that help in intelligent posting of security officers in campus environment not based on physique but fully based on their emotional intelligence within a very short period of time. The study has been able to justified, the need for intelligence posting of security officers to different zones/manning posts on campus considering the emotional intelligence of the officers concerned and not the physique of such or environmental factor of the zone been posted to.

6. ACKNOWLEDGEMENTS

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