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Genetic Algorithm for the Search and Optimal Choice of Girls to School in the Urban Commune of Douentza

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Abstract: ***As part of improving girls' access to and retention in school, several strategies and actions are envisaged. First, it is necessary to briefly recall the nature and multiplicity of obstacles to girls' school education. These obstacles are both of school origin (distance from school, insufficient teaching staff, high cost of schooling, among others) and of extracurricular origin (forms of marriage, place of girls and women within the family, jobs offered to women). The various factors that oppose girls' schooling confront us with a complex situation with varied and intertwined determinants. The automation of the optimal choice of girls to attend school is not or little known by Mali's school authorities. In this paper, we used genetic algorithms to automate the optimal choice of 6-to 9-year-old girls for school access and retention. This method can be a complement to the classic manual strategy of going door to door or using administrative summons and the services of a town crier to achieve the same objectives.***

Keywords: Schooling, Genetic algorithm, Modeling, optimization, Individual, Chromosome, Gene, Genotype, phenotype

1. Introduction

Even today, in many countries, girls' enrolment remains far below that of boys. First, it is necessary to briefly recall the nature and multiplicity of obstacles to girls' school education.

These obstacles are both of school origin (distance from school, insufficient teaching staff, high cost of schooling, among others) and of extracurricular origin (forms of marriage, place of girls and women within the family, jobs offered to women).

The various factors that oppose girls' schooling therefore confront us with a complex situation with varied and intertwined determinants.

To have a positive impact on girls' schooling, it is necessary to develop multiple and complementary proposals, acting on the various registers that oppose female schooling. Social, economic and cultural barriers must be addressed simultaneously, both in and out of school.

Since the dawn of its independence, Mali has embarked on a process of reform of its education system, in order to allow access to education for all.

Mali's concern to take into account all components of society, children and particularly girls, has led Mali to subscribe to commitments at the international level and to implement political and legal reforms at the national level.

Interventions for girls must therefore take into account the factors that exacerbate girls' under-enrolment. They must be articulated and aim to achieve three objectives: school entry, retention in school and academic success.

This study concerns the problem of girls' schooling in the urban commune of Douentza and a proposed solution by applying the concepts of genetic algorithms.

Genetic algorithms are methods based on biological mechanisms such as Mendel's laws [MENDEL 1850] and Charles Darwin's fundamental principle (selection) in 1859 [DARWIN 1859]. More recently, Goldberg in 1989 [GOLDBERG 1989] enriched the theory of genetic algorithms based on the following parallel:

- An individual is linked to an environment by his DNA code,
- A solution is linked to a problem by its quality index,
- A "good" solution to a given problem can be seen as an individual who is likely to survive in a given environment.

1.1 State of the art

The objective here is not to conduct an exhaustive literature review on possible strategies for girls' enrolment and success in school and their ranking.

A large-scale international study on equity in education, "Ending School Failure", published in 2007 [OECD 2007], provides ten broad policy directions on supply, practices and resources. The second "Equity and Quality in Education" report, published in 2012 [OECD 2012], offers five key recommendations to prevent school failure and encourage upper secondary completion, and five others to improve the outcomes of underperforming disadvantaged schools.

Student performance is generally lower in schools where most students come from disadvantaged backgrounds.

The main reason for this is that the socio-economic background of pupils has an important influence on their performance, which many disadvantaged schools are unable to compensate; Worse still, they sometimes accentuate this disadvantage.

According to a study published by the National Institute of Statistics of Niger [INS-IGER 2015], the primary completion rate increased from 15% in 1990 to 75.2% in 2015. This correspond to an increase of 65 points in 25 years, or 2.6 points on average per year. This increase is not sufficient to achieve the 2015 target of 100%.

Burkina Faso, like many other African countries, has embarked on a broad-based education policy aimed at ensuring that as many children as possible have access to school. This policy has raised the gross primary school enrolment rate from 33.9% in 1993 to 77.6% in 2011.

According to the Centre de Recherche et d'Intervention sur la Réussite Scolaire [CRIRES, Canada-Quebec], the concept of academic success is polysemic and multidimensional. Concretely, its study is articulated according to the paradigms adopted by researchers and practitioners. The activity of both, oriented towards academic success, is part of a given time and place. For the purposes of its own activity, this centre has adopted an operational definition of academic success and has set itself research lines on three occasions. Questioned in 2006, the operational definition of academic success still prevails despite the fact that curricula, which have succeeded one another to reflect the evolution of individual and social needs, are instruments that question this concept as well as the means to accomplish it.

Education indicators from the Ministère de l'Éducation, du Loisir et du Sport [MELS, Quebec] show that high school graduation rates among those under 20 years of age are on the rise: from 70.7% in 2003-2004 to 72.2% in 2007-2008. Over the same period, high school graduation rates for adults aged 20 and over increased slightly, from 14.5% in 2003/2004 to 15.1% in 2007/2008 [MEQ, 2004; MELS, 2009].

The target of the Ministerial Action Plan for Education Reform (1997), [MELS 1997], which aimed for an 85% high school graduation rate before the age of 20, was reduced to 80% in 2020 by the MELS in the plan "L'école, j'y tiens! All together for academic success (2009)".

The current configuration of the Malian education system is determined by Law 94-010 of 24 March 1994. This system has the following structures: pre-school education, basic education, general secondary education, technical and vocational secondary education, normal education, higher and university education, to which must be added non-formal education which includes functional adult literacy and the education of out-of-school or out-of-school youth in development education centres (CEDs) or initiatives promoted by NGOs such as Village schools. These various educational structures are administered by two ministries: the Ministry of National Education for basic educational structures (preschool and special education, basic education, non-formal education) and the Ministry of Higher Education and Scientific Research, which manages the structures, universities and other training institutes.

An analysis of the evolution of the gross enrolment ratio over the past decade reveals the rapid progress made in enrolment during this period: the gross enrolment rate rose from 26 per cent in 1988/89 to 53.9 per cent ten years later in 1998/99. It should be remembered, however, that the calculation of crude rates gives rise to imprecisions and that the criteria for taking into account the numbers of pupils in the first basic cycle have undergone changes which distort statistical analysis. Thus, the numbers of students enrolled in madrasas are now taken into account for the calculation of the gross rate, which was not the case at the beginning of the 80s.

The end of the 80s and the 1990s were marked by an increase in funding for education, thanks in part to the support of international cooperation that provided funding for the Fourth Basic Education Development Project (PDEB) (USAID, World Bank, Kingdom of Norway, France, Canada, etc.). The development of the school offer has generated a certain enthusiasm for schools in both urban and rural areas; The gross enrolment rate then increased rapidly.

Despite the significant progress made, the indicators used show the low enrolment of children of primary school age.

Taking into account the net enrolment rates calculated by the Planning and Statistics Unit, we see that just over a third of children aged 7 to 12 are in school, even if, as the SPC notes:

"After stagnating at 20% during the 80s, the net enrolment rate for 7-12 year olds reached 39.1% in 1997/98, almost double in 8 years" (Mali, 1999).

The Malian school system is characterized by very strong regional disparities and gender inequalities, which are as much the result of the lack of state supply as of family demands, which are sometimes very reserved about schools.

The past five decades have been marked by debates about girls' schooling in developing countries. The Universal Declaration of Human Rights of 1948 states that every individual has the right to education and, to this end, the United Nations has called for it to be free and compulsory at the elementary level. In the same vein, the UNESCO Convention [UNESCO 1962] also invited all States to formulate policies conducive to the promotion of equal opportunities at all levels of education in order to ban discrimination in all its forms. In the same vein, the International Education Conference on Improving the Efficiency of Education Systems and Reducing Enrolment Losses at All Levels of Education, convened in Geneva in 1970, drew the attention of education authorities to the academic progress of pupils. The World Conference of International Women's Year in 1975 in Mexico City called for studies to be undertaken to better understand the loss of female school enrolment. Also, the United Nations Convention in 1981 and the World Conference on Education for All, held in Jomtien in 1990, reiterate the need to give girls equal opportunities to access education in society.

However, despite all these conventions and declarations, or the interventions of various projects in support of Basic Education, disparities between boys and girls in enrolment and retention remain worrying in schools in Mali.

It is up to each country to develop strategies adapted to its people according to socio-economic, cultural and religious contexts.

For example, Mali has adopted a national policy for girls' schooling.

1.1.1 National strategies

The overall strategy will be to bring education at all levels and eliminate stereotypes about the roles of men and women, keep girls in school, reduce gaps between enrolment indicators between girls and boys and ensure quality learning.

In this context, emphasis will be placed both on the adoption of measures for the overall development of the education system and on specific measures for the enrolment of girls.

To achieve this, the following strategic priorities have been selected:

1.1.2 Access to and retention of girls in school

Particular attention will be paid to the development of specific support measures for girls' schooling by:

- Enrolment of girls in the first year of basic education, from the age of 6;
- The generalization of gender parity in enrolment in the first year of basic education;
- The generalization of incentives for girls' enrolment in school (support for girls from poor families, halving of girls' registration fees);
- The design and implementation of a sponsorship system;
- The development of tutoring and school support systems

Pupils-pupils, young pupils and adults-pupils;

- The development of girls' effective participation in the life of their school;
- The establishment of incentives for the recruitment of women teachers in rural areas;
- The implementation of specific local strategies for the schooling of girls in difficult situations;
- Strengthening vocational training leading to qualifications for women and girls;
- Strengthening literacy for women and girls;

1.1.3 Quality

Emphasis will be placed on:
- Strengthening the capacity of structures to boost and monitor the strategy of girls' schooling;
- The implementation of the policy of initial and in-service training of teachers taking into account the gender aspect;
- The mobilization of structures and resources for the implementation of girls' schooling;
- The adaptation of programmes to the training and socio-professional integration needs of CED learners;
- Strengthening advocacy and implementing a communication plan for girls' schooling;
- Integration of life skills modules into curricula;
- The development, production and dissemination of appropriate teaching materials.

A new technique for schooling strategy, still little exploited in the educational environment but nevertheless very promising, is the technique of genetic algorithms.

This optimization technique makes it possible to make an optimal search and choice of candidates for schooling through a space of solutions.

2. Problem

The implementation of the girls' enrolment strategy for girls' access to and retention in school was as follows:

- At the beginning of each school year, a summons is given to the parents of the girl who is of school age,
- A week before the start of the school year, a town crier goes around the village beating a drum to inform about the start of the school year.

The problems with this way of recruiting girls to school are manifold:

- The non-response of the parents to the summons,
- The inaccuracy of the physical existence of the candidate,
- The authorities' lack of knowledge about families with daughters who are potentially candidates for schooling.

The non-response to the summons is due to ill will, to a religious belief hostile to the school of the "white", to the role of the girl in the family, to self-exclusion by saying that the school is for the children of the rich or simply to ignorance. Some ethnic groups are nomadic and thus the schooling of their children becomes difficult.

Authorities often use sanctions ranging from community service to three-day imprisonment.

Children's births are not often reported in health centres, making access difficult.

Nowadays, the authorities have been able to sensitize the population on the need to give birth in health centers to at least have a health and that of the child. Once at the health centre, births are recorded in a register. The communal authorities collect birth registers from health centres and issue birth certificates.

The town hall submits birth certificates to the Academy of Education, which recruits girls at school from the age of 6.

Choosing girls to attend school is a long and difficult process. The parameters involved in choosing a girl are complex and intertwined.

It is an annual routine that deserves to be optimized.
Optimization methods by genetic algorithms are known to give excellent results in both small and large research spaces. For the problem treated, the study space is made up of girls from the urban commune of Douentza.

Therefore, in order to evaluate possible solutions for this type of problem, we propose, during this study, to use a particular evolutionary method (Genetic Algorithms) for the implementation of national strategies for girls' schooling, taking into account certain particularities in this region.

A. Genetic algorithms (GA)

Genetic algorithms are algorithms based on the mechanisms of genetics and the evolutionary principles of natural selection of Charles Darwin [Darwin 1859]. These techniques stated that the individuals best able to survive will reproduce more often and have more descendants.

They were adapted for optimization by John Holland in the 1970s [J. HOLLAND 1970].

The operation of genetic algorithms is simple: we start from a population of individuals of initial solutions; their relative performance is evaluated; Based on these performances, a new population of potential solutions is created using evolutionary operators such as selection, crossing and mutation. Some individuals reproduce, others disappear and only the best adapted individuals are expected to survive. By repeating this cycle several times, we get a population composed of better solutions.

The implementation of the genetic algorithm can be summarized by the following nine elements:

- Coding of individuals
- The Initial Population Generation
- Fitness function
- Selection
- Crossing
- Mutation
- Optimization
- Replacement
- The Stopping Criterion

Generic genetic algorithm

1) Generate a population of individuals of size n: x1, x2, x3, . . ., xn
2) Until the termination criterion is met, do:
3) Assess the degree of adaptation of each individual in the current population
4) Select a set of high-quality individuals
5) Apply to each of the selected pairs of individuals the crossing operator that will produce one or more "child" individuals
6) Apply a mutation operator to the individuals thus obtained
7) Replace a portion of the current population consisting of low-quality individuals with high-quality "child" individuals
8) Possibly mutated individuals constitute the new generation of the population

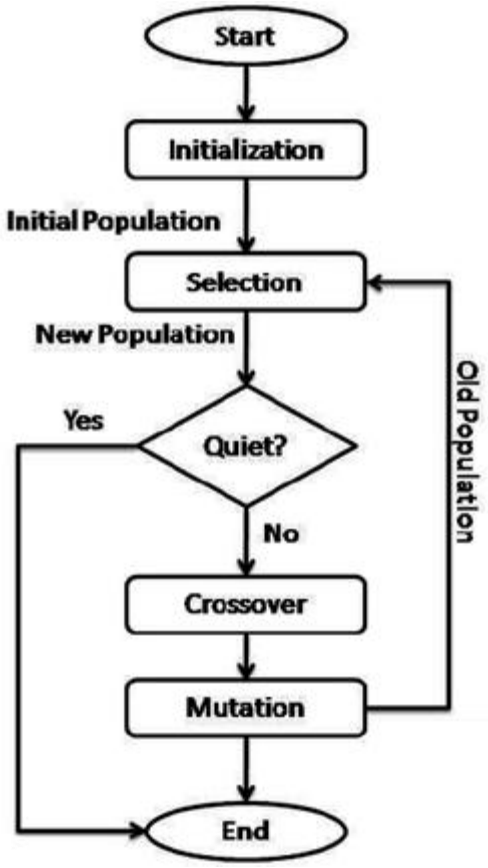

Figure 1: Generic genetic algorithm

a) Coding of individuals

Individuals correspond to the "solutions" of the problem to be optimized. These solutions must be "coded". This encoded representation of a solution is called a chromosome, and is composed of genes.
A genetic algorithm deals with individuals made up of a single sequence of genes called a chromosome, whereas biological organisms may have several. The computational approach idealizes the chromosome by reducing it to a gene vector.

- **Gene:** it is a basic segment of chromosome. It characterizes the value of a variable of the solution to the problem that the genetic algorithm addresses.
- **Population:** set of artificial or natural individuals.
- **Mutation:** random change of an allele during the reproductive phase.
- **Allele:** An allele is a variable version of the same gene, i.e. a varied form that can be distinguished by variations in its nucleotide sequence. There are usually a few alleles for each gene, but some genes have several dozen alleles:

Several types of encoding are used: Binary encoding, Multi-character encoding (or real encoding), Tree encoding.

b) Population generation

The population is the set of individuals of the same generation. Initially, you have to generate this population. The initial population must be sufficiently diverse and large enough in size so that research can traverse the study space in a limited amount of time.

c) The Accommodation Function

It is the function that evaluates the performance of each individual. We then seek to optimize this function. The adaptation function ensures that successful individuals will be retained, while poorly adapted individuals will be phased out.

d) Selection

Selection makes it possible to choose the individuals with which the reproduction operations will apply for the creation of the future generation. There are different selection techniques like Uniform Selection, Roulette Selection, Rank Selection, Tournament Selection.

e) The Crossing

The crossing applies with two parents and generates two children. We have several methods for crossing two chromosomes, such as Single or N-Point Crossover, Uniform Crossover, and Logical Crossover.

f) Mutation

A mutation is the reversal of a random gene in a chromosome. The mutation operator is a process where a minor change in the genetic code is applied to an individual.

g) Optimization

It must be ensured that the creative function of individuals always creates valid individuals and that genetic operators retain the validity of the treated individuals.

h) Replacement

This operator consists in reintroducing the offspring obtained by the application of genetic operators into the population of their parents. There are essentially two alternative methods: Stationary Replacement and Elitist Replacement.

i) The Stop Test

A genetic algorithm ends after a certain number of generations, or when a certain set condition is met, or when the population has converged.

B. Main parameters

The operators of the genetic algorithm are guided by a number of given

Structural parameters. The value of these parameters influences the success (or not) and speed of the algorithm. Let's briefly present these main parameters:

1) The size of the population n and the coding length of each individual. It is preferable to take a population size corresponding to the length of the coding of the individuals. If n is too large, the calculation time is very important. On the other hand, if n is too small the algorithm converges too quickly;
2) The probability of crossing pc. It depends on the form of the performance function. Accepted values are generally between 0.5 and 0.9 [E. ZITZLER 1999]. The higher the population, the greater the population undergoes. Convergence is very fast if pc is close to 1;
3) The probability of mutation pm. This rate is generally low. A high rate may modify the best individuals and this leads to the distance from optimality [E. ZITZLER 1999].

Modelling the problem of girls' school enrolment

This modelling phase is essential for the implementation of girls' schooling strategies in the urban commune of Douentza. In the case of genetic algorithms, the implementation of a problem is essentially descriptive: it is necessary to define evaluable models of the attributes of the problem and the form of the solutions sought in order to be able to solve it.

The modeling of the problem to be solved (schooling of girls who are the potentially solution individuals) will be achievable by a natural description of the real world.

However, the use of a genetic algorithm has a disadvantage: being a stochastic method and, therefore, not complete, it does not provide the complete set of solutions to the problem. At most we could reach as many solutions as individuals of the population but, due to the convergence mechanism (based on the propagation of the best characteristics of each individual), the latter is very homogeneous and, therefore, there is a good chance that several solutions are identical.

The urban commune of Douentza is the space for studying the population of the genetic algorithm, girls represent the individuals (chromosomes) of this space and the elements that characterize the individuals of the population (age, economic situation of parents, social environment, school environment, contribution of teachers, among others) allowing their evaluation (creation of a "fitness" adaptation function among others), will represent the genes of individuals.

The greatest difficulty will then be to design the functions of evaluation of the different attributes of individuals.

Modeling individuals

To model any problem is to write it down from a mathematical point of view.

The stages of modeling [D. Johann, A. Petrowski, P. Siarry, E. Taillard. Eyrolles 2003]:

- Identification of decision variables.
- The description of the method that allows the state concerned to be evolved, given a configuration of decision variables.
- The mathematical description of the circumstances, or constraints specifying the values that decision variables can take.
- The objective function.

Schooling Genetics Algorithm Flowchart

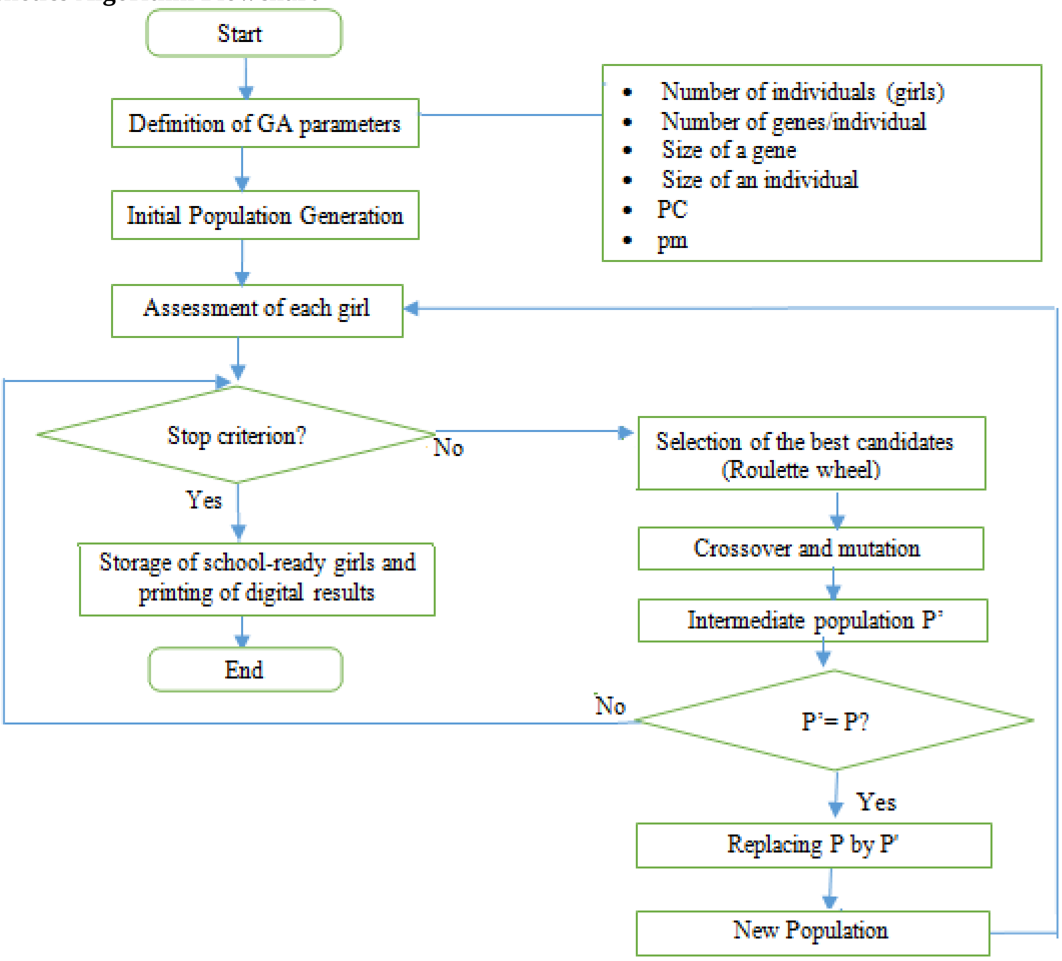

Figure 2: Flowchart of the genetic algorithm for schooling

C. Genetic coding of individuals

The Genetic Algorithm considers a population of F individuals, an individual is equivalent to a girl to schooling F= (F1, F2, . . . Fn). An individual can then be represented by one or more chromosomes. The set of characteristics of an individual (girl, or chromosome) forms a chromosome. The characteristics (genes) are the assessment variables of the girls, i.e. the economic situation of the parents, the level of education of the parents, the rigor of the parents, the social environment, the school environment, the contribution of teachers, distance from school.

Each chromosome then contains a chain of genes representing the coded variables of the problem.

A gene will be represented by a 5-bit integer (with the following ratings: from 18 to 20 Excellent, from 16 to 17 very good, from 14 to 15 good, from 12 to 13 fairly good, from 10 to 11 fair, from 5 to 9 insufficient, from 0 to 5 zero) for the assessment of the characteristics of girls. Girls who will have an average of 10/20 or higher are assumed to be potentially fit. Chromosomes that are sequences of genes are represented by arrays of genes.

Gene:

Economic situation of the Parents	10100

Chromosome

1	2	3	4	5	6	7	8
Parents Econom Situ. .	Parents level ot Instr.	Parents' Rigor	IntrinsicValue of the child	school Distance	school Environ.	teachers contrib.	Social Environ.

	Genes							
Chromosome	g1	g2	g3					g8

Chromosome

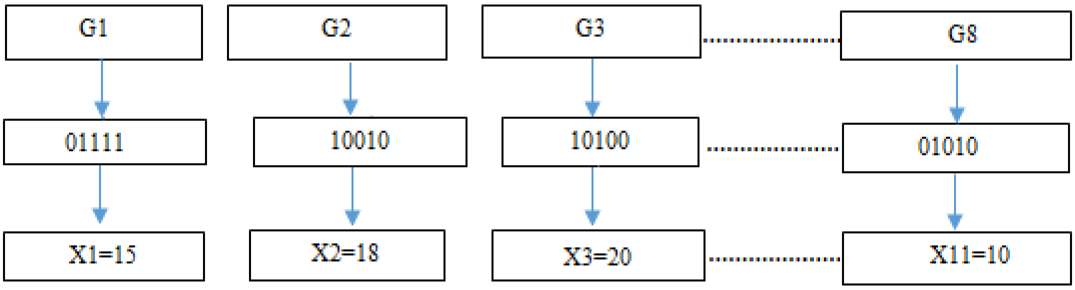

Figure 3: Representation of genes and chromosomes

Definition of the Parameters of the Genetic Algorithm

Prior to its use, the GA required the definition of the probability of crossings, mutations, population size and maximum number of generations.

In our study, the following parameters are retained:

- Population size 1000
- The size of a chromosome 8 genes of 5 bits each or 40 bits
- Number of generations or stopping criterion 500
- Probability of crossing 0.7
- Probability of mutation 0.001

Initial population generation

The initial population is randomly generated according to the number of genes on each chromosome, and the number of individuals in the population.

The following table gives an example of an initial population (F0) of five individuals (N = 5) represented by the chromosome of eight genes.

Table 1: Initial Population

Fo (i)	Chromosome
F1	12 13 14 8 16 3 9 6
F2	2 11 19 15 4 16 15 10
F3	11 14 15 16 17 11 12 18
F4	2 10 15 18 4 2 9 14
F5	9 7 11 15 12 14 15 1

D. Evaluation of individuals

A "fitness" performance measure must be calculated for each chromosome.

This makes it possible to identify the best individuals in the population and it is they who will have the best chance of reproducing in future generations.

The construction of the performance function is obvious for some problems. For maximization problems, for example, the performance function can be equal to the objective function.

In our case the performance function is the sum of the values of the genes of a chromosome since the higher the value of the chromosome, the more likely it is to be chosen.

$$\text{Fit (i)} = \sum g\,(j) \text{ with } i=1...5 \text{ and } d=1...$$

After evaluating individuals, they are classified according to their quality.

The purpose of this step is to rank individuals in the population in order to decrease with respect to the value of their Fit (i) assessment function.

So, after this ranking, the highest performing individual, or the one with the highest Fit (i) value is located in the first position while the least performer is located in the last position relative to the other numbers in the group.

Table 2: Evaluation of each individual's performance measure

Individual	∑g (j)	∑g (j)/∑F (i)
F1	81	0, 182
F2	92	0, 206
F3	114	0, 256
F4	74	0, 166
F5	84	0, 188
TOTAL	**445**	1, 000

E. Selection

The genetic algorithm favors the reproduction of individuals who are best adapted to their environment over others who are less so. To achieve this, only a certain number of parents are chosen from the population to form the breeding set. These parents are randomly selected from the population with the imposition of a bias in order to make it more likely that the best individuals, i.e. those with the highest value of the Fit (x) evaluation function, will be drawn. The biased lottery or roulette wheel is the best known and most used method.

It consists in associating each individual with a sector of roulette whose surface is proportional to his performance. We then draw a random number of uniform distribution between 0 and 1, then we look at which is the selected sector, and we reproduce the corresponding individual. The figure illustrates a roulette wheel in which each individual is assigned a sector whose angle is proportional to his performance given by the equation:

$$P\,(i)=\sum g\,(j)/\,(\sum F\,(i)).$$

In this way, the higher an individual's Fit (i) quality compared to the rest of the population, the more likely it is to reproduce.

However, since selection is random, the worst individuals still have a chance to be part of the breeding set.

Table 3: Selection of individuals

Individual	∑g (j)	∑g (j)/∑F (i)

F1	81	0, 182
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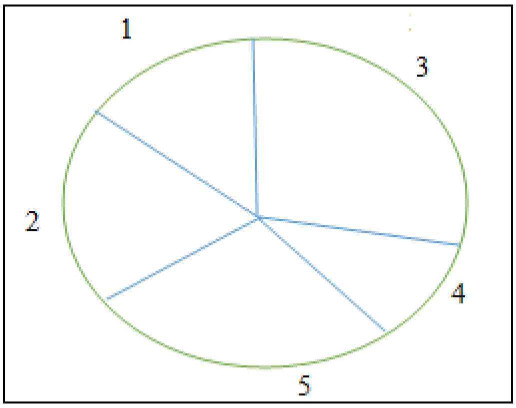

Figure 4: Roolet weel

3. Crossover

The crossing used by genetic algorithms is the computer transposition of the mechanism that allows, in nature, the production of chromosomes that partially inherit the characteristics of the parents. Its fundamental role is to allow the recombination of information present in the genetic heritage of the population.

This operator is applied after having applied the selection operator on the population F0; we therefore end up with a population F0' of n/2 individuals and we must double this number for our new generation to be complete.

We will therefore randomly create n/4 pairs and make them "reproduce".

The chromosomes (sets of parameters) of the parents are then copied and recombined so as to form two offspring with characteristics from both parents.

Let's detail what happens for each couple at the level of each of their chromosomes:

One, two, or even up to lg-1 (where lg is the length of the chromosome) crossing points (loci) are drawn at random, each chromosome is therefore separated into "segments". Then each segment of parent1 is exchanged with its "homologous" of parent2 according to a crossing probability pc. From this process results 2 sons for each couple and our population F0' therefore now contains n individuals.

It can be noted that the number of crossing points as well as the crossing probability pc make it possible to introduce more or less diversity.

Indeed, the greater the number of crossing points and the higher the probability of crossing, the more there will be exchange of segments, therefore exchange of parameters, of information. The smaller the number of crossing points and the lower the probability of crossing, the less diversity the crossing will bring. It can be noted that the number of crossing points as well as the crossing probability pc make it possible to introduce more or less diversity.

Below is a diagram illustrating a one-point crossover, another for a two-point crossover, for our example.

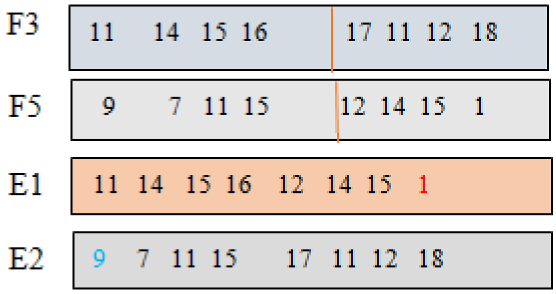

Figure 5: Crossing at a point

F. Mutation

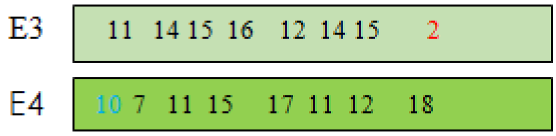

Figure 6: Mutation

As in nature, the genetic algorithm simulates mutation processes. Indeed, the mutation modifies certain genes of the individuals of a population in a random way to replace them by other values determined also randomly. In the genetic algorithm, the mutation operators intervene after the crossover step and apply to the set of children generated by the reproduction.

Moreover, the mutation can modify only one gene per individual of the population according to the probability pm of the operator. On the other hand, it is sometimes desirable to further disrupt the genes of the population by allowing the mutation of more than one gene per individual. Thus, multiple mutation is a variant of single mutation. It then applies to all the genes of each individual in the population with a lower probability than a single mutation. So, with this last operator, it is possible that more than one gene is mutated within the same individual.

G. Replacement

We apply the replacement operator which decides to replace 100% of the population P, the population P is therefore entirely replaced by P' and its size remains fixed:

Table 4: The new population after application of the different operators

Individual	Genes	Fitness	% of sum
child1	11 14 15 16 12 14 15 1	98	0, 191
child 2	9 7 11 15 17 11 12 18	100	0, 195
F3	11 14 15 16 17 11 12 18	114	0, 222
child 3	11 14 15 16 12 14 15 2	99	0, 193
child 4	10 7 11 15 17 11 12 18	101	0, 197
sum		512	

H. Stopping criterion

In our work, the algorithm stops when the number of generations is reached.

4. Results and Discussion

The procedure described above was therefore implemented and the desired results were identified by the genetic algorithm. After several executions of the algorithm with different values, the results obtained are interpreted by the table5 above.

The experimental results on the optimization problem clearly show the existence of a relationship between the results found and the parameters of the genetic algorithm. If the latter is rich in terms of the diversity of the solutions generated, it is difficult to parameterize (size of the population, number of generations, probability of crossing, probability of mutation).

However, one finding was obvious for the schooling optimization problem, the use of a small population quickly leads to the solution even with a large number of evaluations of the adaptive function, as indicated by table 1. It therefore seems that choosing a small population size is not a promising way, although such a choice is not costly in terms of time.

The genetic algorithm which has the advantage of improving during its execution the best potential solution identified at the end of each generation has adopted a certain strategy. This consists of keeping each time the best solution between the current one and its previous one. In this way, it keeps only the good solutions since it abandons a solution if the antecedent is better. This mechanism is triggered at the end of each generation to keep the best solution which will be the basis of the next generation. The objective of this strategy is to improve the solutions from the first generation until the end of the descriptive process of the genetic algorithm. However, the least good solutions, i.e. girls less suitable for automatic enrollment, will be included on a list that will be given to the projects responsible for helping girls' education.

The difference with the traditional manual method of registering girls in school is that the algorithm provides a list of potential candidates for registration. The authorities of the teaching academy will only distribute the candidates to the various establishments. It should also be noted that this new method will create a relationship of symbiosis between the urban population of Douentza, the town hall and the teaching academy.

As for the retention and success of girls in school, the procedure will be as indicated in the specific objectives of the national policy for the education of girls:

- The generalization of incentive measures for the enrollment of girls in school (support for girls from poor families, halving of enrollment fees for girls);
- The design and implementation of a sponsorship system;
- The development of tutoring and school support systems

Pupils-students, young-students and adult-students;

- Reduce the percentage of repeaters;
- Improve the completion rate for girls;
- Enable at least 80% of girls enrolled in basic education and non-formal education to master basic learning and essential life skills, including in terms of Sexually Transmitted Infections (STIs) and HIV/AIDS.

5. Conclusion and perspectives

The objective of this article is to be able to apply the techniques of genetic algorithms to the process of schooling children. Traditional and manual schooling methods are automated using genetic algorithm techniques. There was an improvement in access to and retention of girls in school, the reduction of the disparity between girls and boys and the success of girls in school. . By using genetic algorithms, the results on the plan, the best candidates among many others are obtained. A list of potential candidate girls is automatically generated and a distribution between the establishments is carried out. However, those who are not included in the official list will be the subject of special assistance by the authorities or non-governmental organizations responsible for the matter.

The problem of schooling for nomadic children and those of families not listed by the town hall, that is to say children not declared at birth, still remains.

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