Deriving Priority in AHP using Evolutionary Computing Approach

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Abstract: - In the real world, human will face the problem and dilemma to making decision. Making decision is the critical part in choosing the best solution. Multi-criteria decision making (MCDM) is one of the most well known branches of decision making and it is referring to making decision in the presence of multiple criteria. MCDM problem are common occurrences in everyday life. In 1977, Saaty introduced Analytic Hierarchy Process (AHP) to solve the MCDM problem. The AHP is widely used for MCDM. Since AHP has been introduced, it has been applied in numerous situations with impressive results. However, AHP has been also criticized in the literature review, mainly in priority derivation procedure. This paper has identified three main problems in current priority derivation procedure which are: (1) Inconsistency of the judgment, (2) Non-evolutionary computing approach, and (3) Accuracy performance of the prioritization method. To solve the criticism and the problems; this paper proposes AHPEC which is using Evolutionary Computing (EC) to derive priorities in AHP. The AHPEC gives better result compare to the other prioritization methods based on accuracy of derived priorities. The comparison is based on the value of Total Deviation (TD) which is measure accuracy o the solution. The case study from Srdjevic, 2005 was chosen to compare the performance of the AHPEC and the current prioritization methods based on accuracy of the solution as a criterion to be optimized.

Key-Words: - Decision making, Analytic Hierarchy Process (AHP), Evolutionary Computing (EC), and Web-based Decision Support System (WDSS).

1 Introduction

Decision Making is a process of choosing among alternative courses of action for the purpose of attaining a goal or goals [1]. Multi-criteria Decision Making (MCDM) refer to making decisions in the presence of multiple criteria. The MCDM could solve process typically involves the phase of problem structuring, prioritization, selection, evaluation of the criteria and alternative and synthesis.

The Analytic Hierarchy Process (AHP) is the well-know and popular method of MCDM [2]. Nowadays, AHP has been use in many areas such as in social, personal, politic, education, government, management, sport, industry, and so on. Since AHP has been introduced, it has been applied in numerous situations with impressive results. However, AHP has been also criticized in the literature review, mainly in priority derivation procedure.

The main component of AHP is priority derivation procedure, the process of deriving scores in order to set the relative order of importance of alternatives. The priority derivation can be done by using prioritization method. Prioritization method is used to derive priorities in AHP.

This research found three main problems in priority derivation procedure in AHP**.** The first one is the problem with the inconsistency of the judgments. The consistency of the judgment is important in making decision. However, inconsistency of the judgment always happens and it will affect the accuracy in selecting alternative. Second, the effect of using non-EC prioritization methods in deriving priorities, and the last is the accuracy performance of the non-EC prioritization methods.

This paper proposed a priority derivation procedure based on Evolutionary Computing (EC) in AHP (AHPEC) in order to solve the mention problems.

2 Analytic Hierarchy Process (AHP) Problems

In 1977, Saaty [3] introduced AHP to solve the Multi Criteria Decision Making (MCDM) problem. MCDM is referring to making decision in the presence of multiple criteria. The typical MCDM problem often requires the decision maker to provide qualitative assessments for determining the performance of each alternative with respect to each criterion and the relative importance of the evaluation criteria with respect to the overall objective of the problem [4].

The AHP has proven to be a powerful decision analysis technique in the area of MCDM, and has been successfully applied to the tackling of MCDM problems [5]. Anton et al. [6] and Oddershede et al. [7] also employ the AHP method to solve their decision-making problems.

According to Cheng et al. [8][9], AHP method helps decision-makers' organize the critical components and aspects of a problem into a hierarchical structure similar to a family tree. By reducing complex decisions to a series of simple pairwise comparisons and rankings, then synthesizing the results, the AHP not only helps the analysts to arrive at the best decision, but also provides a clear rationale for the choices made.

Zahedi [10] summarizes the original AHP procedure by Saaty into four phases:

1) Break the decision problem into a hierarchy of interrelated problems.
2) Provide the matrix data for pairwise comparison of the decision elements.
3) Using Eigenvector Method (EV) as a prioritization method.
4) Aggregate the relative weights of the decision elements to obtain a rating for decision alternatives.

The more detail explanation about calculation of applying AHP method are was discussed in Jiang et al. [5] in section 2.1.2, Weight Sets Determination.

Since AHP has been introduced, it has been applied in numerous situations with impressive results. However, AHP has been also criticized in the literature review, mainly in priority derivation procedure. The priority derivation procedure is the process of deriving scores in order to set the relative order of importance of alternatives.

There are many prioritization methods were introduced since Saaty introduced EV. These methods are: WLS, LLS, LGP, and FPP. All these methods are an optimization based prioritization methods.

Eigenvector method (EV)

The original to deriving priorities in AHP is Eigenvector method (EV) which is introduced by Saaty[3] in 1977. Saaty had proves that the principal eigenvector of comparison matrix can be used as the desired priority vector by using Forbenius Theorem. That why, EV is based on solving the equation:

$$Aw = \lambda w, \; e^T w = 1 \qquad (1)$$

This method gives reasonably good approximation of the priorities vector for small deviations around the consistent ratios w_i/w_j. However, when the inconsistencies are large because of the decision maker preference, it is generally accepted that solutions are not so satisfactory.

Logarithmic Least Square Method (LLS)

This method is also known as Geometric Mean Method. The LLS defining objective function of the following optimization problem:

$$\min \sum_{i=1}^{n} \sum_{j>i}^{n} \left[\ln a_{ij} - (\ln w_i - \ln w_j)\right]^2 \qquad (2)$$

Subject to the multiplicative normalizing constraints

$$\prod_{i=1}^{n} w_i = 1, \quad w_i > 0, i = 1,2,\dots,n. \qquad (3)$$

In proved the validity of LLS, Crawford and Williams [11] have show that the solution for problem (3). The result is unique and can be found simply as the geometric means of the columns or rows of matrix A:

$$w_i = \prod_{j=1}^{n} a_{ij}^{1/n}, \quad i = 1,2,\dots,n. \qquad (4)$$

Weighted Least Square Method (WLS)

The WLS is proposed by Chu et al. [12] as a modification of the direct least-squares method (DLS). This method solving the following constrained non-linear optimization problem:

$$min \sum_{i=1}^{n} \sum_{j=1}^{n} \left(w_i - a_{ij} w_j\right)^2$$

Subject to

$$\sum_{i=1}^{n} w_i = 1 \quad (5)$$

The optimization problem is transformed into a system of linear equations by differentiating the Lagrangian of (5) and equalizing it to zero. Blankmeyer [13] also shown in this way the WLS present a unique and strictly positive solution (w_i > 0, i = 1,2,…,n).

Goal Programming Method (LGP)

Bryson [14] proposed LGP uses the consideration, that the priorities are desired to satisfy the equalities

$$a_{ij} = (w_i/w_j)(\delta_{ij}^{+}/\delta_{ij}^{-}) = 0, \quad i,j = 1,2,\dots,n, j > i, \quad (6)$$

Where $\delta_{ij}^{+} \geq 1$ *and* $\delta_{ij}^{-} \geq 1$ are deviations variables, which both of them cannot be greater than 1 in the time. The priorities of w_i, $i = 1,2,\dots n$ are obtained as solution of the following linear goal programming problem:

$$\min \sum_{i=1}^{n} \sum_{j>i}^{n} \left(\ln \delta_{ij}^{+} + \ln \delta_{ij}^{-}\right)$$

Subject to

$$\ln w_i - \ln w_j + \ln \delta_{ij}^{+} - \ln \delta_{ij}^{-} = \ln a_{ij}, \quad i,j = 1,2,\dots,n, \ j > i, \quad (7)$$

Where all $\ln \delta_{ij}^{+}$ *and* $\ln \delta_{ij}^{-}$ are non-negative.

Fuzzy Preference Programming (FPP)

The FPP was proposed by Mikhailov [15] states if reciprocal matrix of pairwise comparison is consistent, then $a_{ij}w_j - w_i = 0$ for all i, j = 1,2,…,n, j > i. This linear equations can be represent as a system of m = n(n-1)/2.

$$Rw = 0. \quad (8)$$

If pairwise comparison is inconsistent, it is desirable to find such values of w, so that (8) is approximately satisfied, i.e. Rw≈0.

This method showed (8) geometrically as an intersection of fuzzy hyper lines. It also transforms the prioritization problem to optimization one, determining the values of the priorities that correspond to the point with the highest measure of intersection. By using this method, the prioritization problem is reduced to a fuzzy programming problem that can easily be solved as a standard linear program:

$$maximize\ \mu \quad (9)$$

Subject to

$$\mu d_j^{+} + R_j w \leq d_j^{+}, \quad \mu d_j^{-} - R_j w \leq d_j^{-}, \quad j = 1,2,\dots,m \quad 0 \leq \mu \leq 1,$$

$$\sum_{i=1}^{n} w_i = 1, \quad w_i > 0, \quad i = 1,2,\dots,n, \quad (10)$$

Where the values of the left and right tolerance parameters d_j^{-} and d_j^{+} represent the admissible interval of approximate satisfaction of the crisp equality $R_jw = 0$.

The measure of intersection μ is suggested in as natural consistency index of the FPP. Its value however depends on the tolerance parameters and it was also suggested as reasonable that in practical implementations all these parameters should be set equal [15].

Even there are many prioritization methods that was introduce, it still have weakness. Therefore, this paper has identified three mains problems in current priority derivation procedure which is explained in the next section.

2.1 Inconsistency of the judgment

The original prioritization method that has been proposed is Eigenvector Method (EV) by Saaty in 1977. Consistency in EV is measured by using consistency ratio (CR). It is designed in such a way if the value of CR greater than 0.10 which indicates an inconsistency in the judgments was happens. When inconsistency of the judgment happens, it will affect the accuracy in selecting alternative. Then, the decision maker must repeat the judgment again until the decision maker gets the value of CR equal to 0.10 or less.

Because of these problems, a new prioritization method which can derive priorities in AHP in both situations, consistent or inconsistent of the judgment is needed.

2.2 Non-evolutionary computing approach

In deriving priorities, there are two approaches in AHP: the non-optimization approach and the optimization approach. The non-optimization approach is referring to Eigenvector Method (EV), which is the original prioritization method in AHP. For the prioritization methods in optimization approach, they share the same characteristic where priorities are derived by solving single objective optimization problem (SOP) using non-EC approach. Table 1 shows the list of non-EC prioritization methods that have been proposed by previous researchers to derive priorities in AHP.

Table 1: List of non-EC prioritization methods from previous researchers

Author	Prioritization Method
Srdjevic [16]	Combining different prioritization method
Mikhailov [15]	Fuzzy Preference Programming (FPP)
Bryson [14]	Goal Programming Method (LGP)
Crawford and Williams [13]	Logarithmic Least Square Method (LLS)
Chu et al. [12]	Weighted Least Square Method (WLS)
Saaty [3]	Eigenvector method (EV)

However, the non-EC approach has several weaknesses which are:

- When specific problem knowledge is not available, the optimal solution is difficult to generate.
- Several optimization runs are required to obtain the optimal solution.

2.3 Accuracy performance of the prioritization method

The accuracy of the solution can be measured by using Total Deviation (TD). TD is used as an objective function to measure accuracy of the solution to solve SOP. The smaller or close to zero value of TD is the most accurate in term of solution. TD is presented as:

$$TD = \sum_i \left(\sum_j \left(\frac{w_i}{w_j} - a_{ij} \right)^2 \right)^{1/2}$$

Table 2 shows the comparison of performance between non-EC prioritization methods based on TD as objective function for two case studies. For the case study 1 which is problem of reservoir storage allocation, the best prioritization method is LLS. However, for case study 2 which is selecting the high school, the best prioritization method is by using FPP.

Table 2: Comparison of accuracy performance of prioritization methods

Case Study	Ranking of the accuracy performance of the solution (TD value)				
	1	2	3	4	5
1.Reservoir storage allocation [16]	LLS	EV	WLS	LGP	FPP
2.Selecting the high school [16]	FPP	WLS	LLS	EV	LGP

Based on the Table 2, even though the performance of LLS is the best method in case study 1, somehow it is not the best method in case study 2. In addition, according to the case study 1, FPP gives the worst result which is contrast to the case study 2 where the method gives the best result among to the other methods. From the results, we can conclude that there is no method is favorable for both cases in term of accuracy performance.

Therefore, this paper proposes AHPEC in solving the problems that has been faced in AHP.

3 The AHPEC

This paper proposed AHPEC which is using Genetic Algorithm (GA), EC technique to derive priorities in AHP. EC uses evolutionary approach which is based on computational model of natural selection and genetics [17]. According to Ghandchi et. al [18], EC are working with the set of potential solutions, which is called population. Each solution item (individual) is measured by fitness function. The algorithm can select individuals with better genetic materials for producing new individuals and further generations.

EC is stochastic adaptive search procedure to find best solutions. It uses the Darwinian principles of “survival of the fittest”. By using this approach, the fittest member has the highest probability of survival and therefore increases in numbers, while the less fit die. Figure 1 shows the general procedure of EC.

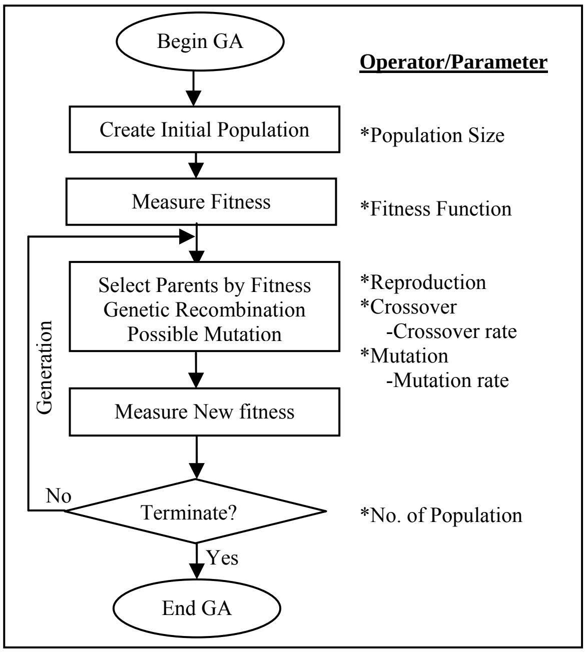

Fig. 1 A general framework for EC.
(referred from Xiaodan Wu et al. [19])

In solving single objective optimization problem for deriving priorities by using AHPEC, it involves three operators which are selection, crossover, and mutation. In this paper, Roulette wheel selection (RWS) has been selected as a method in doing selection. For crossover, this paper using single-point crossover and using uniform mutation for mutation type. In order to ensure that only the best population always survives, elitism has also been applied as an additional selection strategy. Figure 2 shows the scheme using EC in AHP.

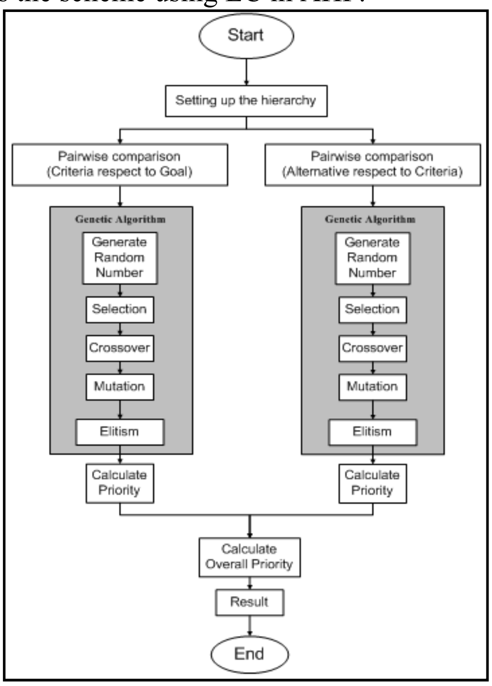

Fig. 2 The Scheme using EC in AHP

Figure 3 represents the algorithm for EC approach in solving single objective optimization problem for priority derivation in AHP.

1- Setting up the hierarchy
2- Insert pairwise comparion
3- Genetic Algorithm Process

3.1- Set the objective function
3.2- Size of population
3.3- Number of generations
3.4- Generate Random Number
- Based on size of matrix
- Calculate TD based on random number and pairwise comparison

3.5- Selection
- Roulette wheel selection

3.6- Crossover
- Using single-point crossover

3.7- Mutation
- Using uniform mutation

3.8- Elitism

4- Calculate Priority (Synthesize judgment)
5- Calculate oveall priority

Fig. 3. The algorithm using EC in AHP framework

Chromosome Representation

This study is using a set of real numbers for each population or chromosome in initial population. The real numbers approaches are use in this study because by using this approach it is more natural and useful representation of priorities in AHP. Besides that, according Herrera et. al [20], by using real number, it would seem particularly natural when tracking optimization problems of parameters with variables in continuous domains. GA based on real number representation is called real-coded GA (RCGA).

Initialization

The initial population of candidate solution is generated randomly across the search space. Search space is the space for all possible feasible solutions [21]. Every solution can be marked by its value of the fitness of the problem. In this study, we are using random numbers to initial population to give AHPCE starting point. Each single population is generating randomly based on number of criteria or alternative in AHP hierarchy setting.

The population size is one of the important factors affecting the performance of EC. If the setting population size is small, it might lead to premature convergence. On the other hand, when the population size is large, it leads to unnecessary expenditure of valuable computational time [22].

Fitness Function

In general, fitness function F(x) is first derived from the objective function and used in successive genetic operations. In this study, we are using Total Deviation (TD) equation as an objective function to be optimized. Once an offspring population is created or the population is initialized, the fitness values of candidate solution are evaluated.

$$F(x) = TD,\ TD = \sum_i \left(\sum_j \left(\frac{w_i}{w_j} - a_{ij} \right)^2 \right)^{1/2}$$

After calculate each initial population fitness function, that chromosome will set as parent. That parent also will produce offspring and store the offspring chromosome. Besides that, that parent also will go to the next step which is selection operator.

Selection

The proportionate selection is selected in this study and it is Roulette Wheel Selection (RWS). Selecting the chromosome by using RWS technique is by looking at their proportional fitness rank. This technique will lead to only the best chromosome been selected in the population where the evolution concept survival of the fittest comes into plays. Figure 4 illustrates the RWS.

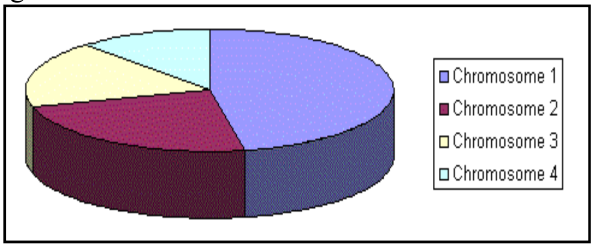

Fig. 4: Roulette Wheel Selection (RWS)

In this operator, the chromosome which is set as parent will apply selection using RWS. After that, the chromosome ready to next step which is crossover operator.

Crossover

After the reproduction or selection phase is over, the population is enriched with better individuals. Selection makes clones of good populations, but does not create new ones. Crossover operator is an exchange gene among chromosomes in mating pool with hope that it would create a better chromosome. This process is to make the solution step forward to search for the optimal point. In exchanging chromosomes, each chromosome will crossover with another one. During this operator, one or more genes will be exchanged between this pair of chromosomes and produce new offspring.

This study is using single-point crossover method. To apply the crossover operation, parent chromosomes will be selected randomly among the population. Figure 5 shows exchanged of the application of crossover operator.

Chromosome 1:	0.336 |	0.287	0.377
Chromosome 2:	0.481 |	0.282	0.237
Chromosome 1:	0.336 |	0.282	0.237
Chromosome 2:	0.481 |	0.287	0.377

Fig. 5: Crossover operator

Mutation

Once crossover is completed, some chromosomes will be selected for mutation. Mutation is a mechanism to alter one or more genes of a selected chromosome to reintroduce lost genetic material and introduce some extra variability into the population [21]. It enables all chromosomes to be considered which cannot be achieved by crossover alone. This operator can be done by randomly choosing one of the genes and changing its value. In addition to that, mutation is applied according to a certain rate which is relatively small. A high mutation rate may lengthen the convergence time. In this study, we are using uniform mutation method. Mutation for real numbers can be done as:

Before	0.336 0.282 0.237
After	0.336 0.456 0.237

Fig. 6: Mutation operator

After perform uniform mutation operator, the new offspring will produce and the new offspring will store in offspring chromosome in applying the next step which is elitism.

Elitism

The elitism technique reserved the best found chromosome in the current population to rebirth for the next generation. By using elitism, it could increase rapidly the performance of AHPEC, because it prevents losing the best-found solution. We could have a chance of losing the best-found chromosome in the current population, when creating new generation using reproduction operator. This is where elitism is important in preventing the lost of this chromosome. In this study, after finish applying selection, crossover and mutation operators, the elitism operator will automatically reserve the chromosomes that produce the lowest of objective function which is Total Deviation (TD) value. The offspring chromosomes that have been store will perform elitism in this step.

Stopping Criterion

The AHPEC procedure is repeated until the maximum number of generation, t. The maximum number of generation, t is in parameter setting that has been set. Figure 7 represents the pseudo code of implementation the AHPEC for more detail steps.

n = size of population
m = size of matrix
k = generation size
Input: the inconsistent matrix A= (a_{ij}) **or** the consistent matrix A'=(a'_{ij})
Output: the priorities estimation in the AHP
1. **for** (i = 1 to n, j =1 to n) **do**
2. generate random number
3. construct column normalized matrix B = (b_{ij});
4. generate random number which the priority W = [w_1,w_2,...,w_m];
5. calculate Total Deviation C = (c_{ij}), cij $= \sum_i \left(\sum_j \left(\frac{w_i}{w_j} - b_{ij} \right)^2 \right)^{1/2}$
6. **end for**
7. **do** selection, crossover, and mutation
8. double maxTotalDeviation = 0; double minTotalDeviation = 0;
9. **for** (i = 1 to n, j = 1 to n) **do**
10. double $TotalDeviation_{ij}$ ← cij;
11. if ($TotalDeviation_{ij}$ > maxTotalDeviation) **then**
12. maxTotalDeviation ← $TotalDeviation_{ij}$;
13. **end if**
14. **else** ($TotalDeviatio_{ij}n$ < minTotalDeviation) **then**
15. $minTotalDeviation_{ij}$ ← TotalDeviation;
16. **end for**

Fig. 7 The pseudo code of AHPEC

To implement EC in AHP, the first step is parent population of population size n is created by generate random number. Then, the fitness value is calculated by using TD as objective function. After that, the operation selection, crossover, mutation and elitism are applied. From that, the new offspring are ready to go to the next generation. The process continued until it reaches the generation size. Fig. 8 shows the procedure of AHPEC in deriving priorities in AHP.

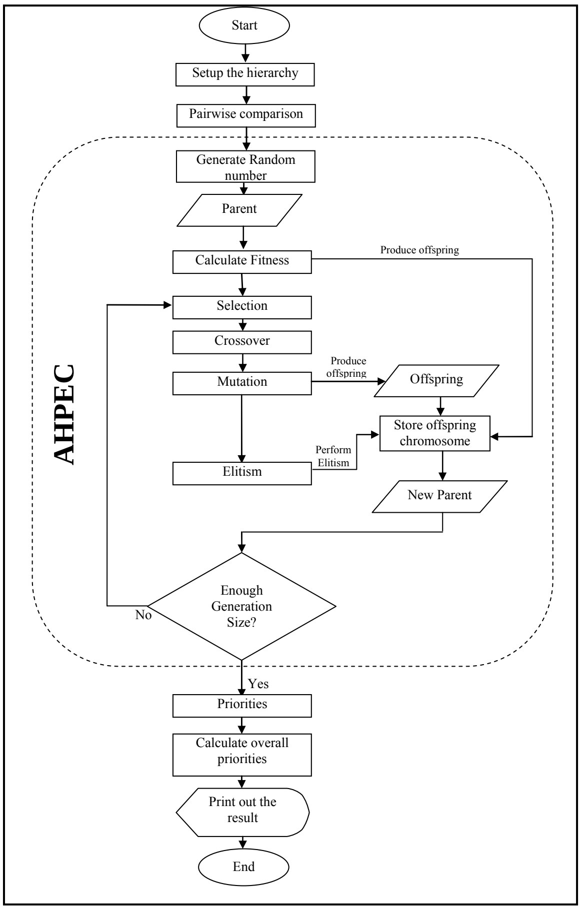

Fig. 8 The procedure of AHPEC

3.1 Parameter Setting

By using EC, parameter setting is the important part in getting the better result. The performance of EC is greatly dependent on its turning of parameter. This paper proposes a new parameter setting. It is tested with two case studies from Srdjevic paper [16]. Table 3 shows the parameter settings for the previous researchers which are Dejong setting [23], Grefenstette's setting [24], and MicroGA setting [25] and the proposed parameter setting for this paper.

Table 3: The parameter setting

Parameter setting	Dejong	Grefenstette	MicroGA	AHPEC
Population size	50	30	5	10
Number of generation	1,000	Not Specified	100	100
Crossover rate	60%	90%	50%	75%
Mutation rate	0.1%	1%	2% and 4%	10%

Fig. 9 and Fig. 10 show the comparison between the proposed setting and others parameter settings. Based on Fig. 9 and Fig. 10, the AHPEC parameter settings give much better result compare to the others parameter settings.

3.2 The results

In applying the procedure of AHPEC and AHPEC parameter setting, an experiment has been conducted based on data that are taken from two case study in Srdjevic's study [16]. The results obtained from his study and the result using AHPEC are list in Table 4 for the first case study which is problem of reservoir storage allocation. The P1, P2, P3, …, P6 represent the pairwise comparison matrix used in the case study. Table 5 shows the second case study which is problem of choosing high schools.

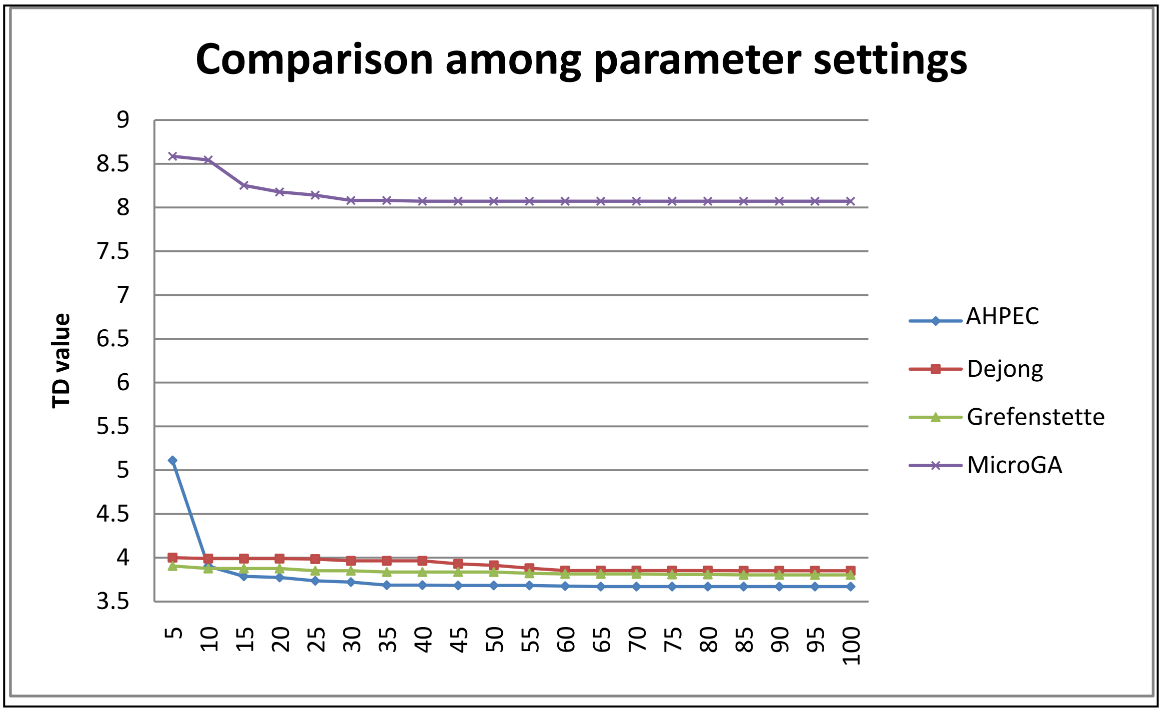

Fig. 9 The result based on four parameter setting (case study 1)

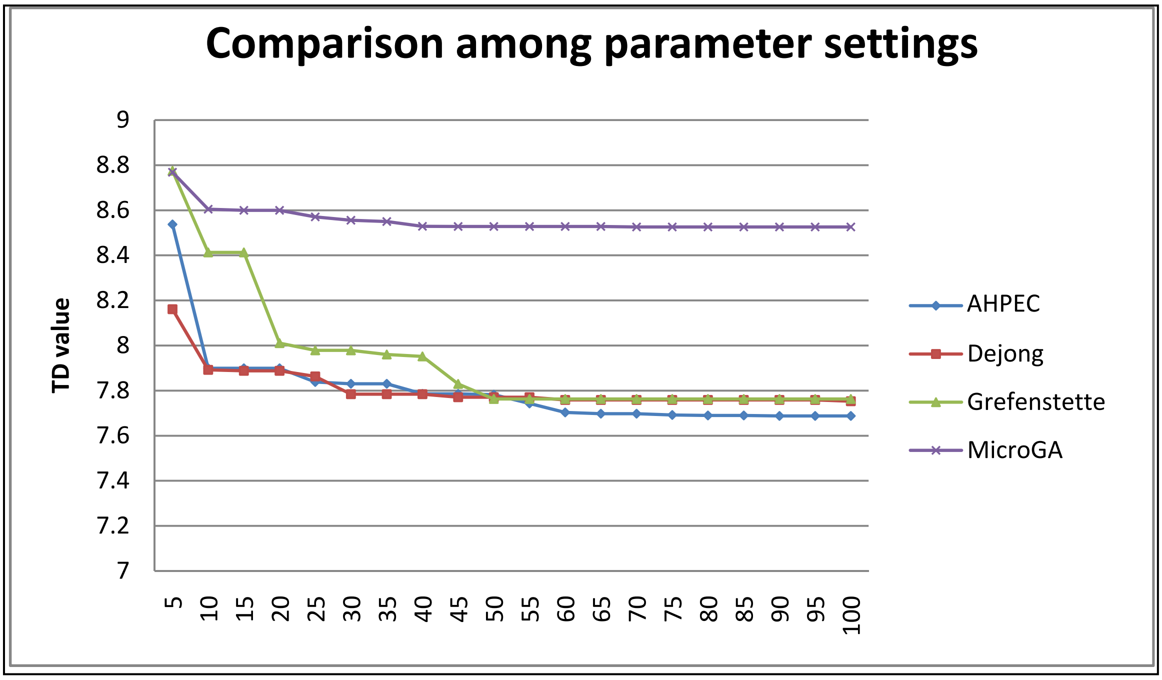

Fig. 10 The result based on four parameter setting (case study 2)

Table 4: The result between non-EC prioritization methods and AHPEC method in term of value of TD in case study 1 from Srdjevic's study [16].

No.	Prioritization method	Value of TD					
		P1	P2	P3	P4	P5	P6
1.	Additive normalization (AN)	4.583	6.209	5.305	6.797	6.107	4.786
2.	Eigenvector (EV)	4.961	6.255	5.359	7.382	6.451	5.055
3.	Weighted least-squares (WLS)	5.508	6.937	5.204	7.114	7.054	5.331
4.	Logarithmic least-square (LLS)	4.813	6.119	5.289	7.327	6.627	4.642
5.	Logarithmic Goal programming (LGP)	5.444	8.027	6.904	7.318	6.634	8.740
6.	Fuzzy preference programming (FPP)	4.550	8.227	5.607	7.005	7.643	8.162
7.	AHP using Evolutionary Computing (AHPEC)	3.667	5.671	4.608	5.849	5.091	4.497
The smaller value of TD		**AHPEC**	**AHPEC**	**AHPEC**	**AHPEC**	**AHPEC**	**AHPEC**

Table 5: The result between non-EC prioritization methods and AHPEC method in term of value of TD in case study 2 from Srdjevic's study [16].

No.	Prioritization method	Value of TD				
		P1	P2	P3	P4	P5
1.	Additive normalization (AN)	8.795	1.063	0.000	0.000	5.011
2.	Eigenvector (EV)	9.479	1.091	0.000	0.000	6.032
3.	Weighted least-squares (WLS)	11.757	0.960	0.000	0.000	3.856
4.	Logarithmic least-square (LLS)	9.235	1.091	0.000	0.000	6.032
5.	Logarithmic Goal programming (LGP)	9.285	1.126	0.000	0.000	3.645
6.	Fuzzy preference programming (FPP)	28.667	1.118	0.000	0.000	3.764
7.	AHP using Evolutionary Computing (AHPEC)	7.748	0.932	0.000	0.000	3.622
The smaller value of TD		**AHPEC**	**AHPEC**	**AHPEC**	**AHPEC**	**AHPEC**

Based on Table 4 and 5, AHPEC produce the smaller or close to zero the value of TD for every single P1, P2, …, and P6. These result also show that the AHPEC can be use to derive priorities for both situation of inconsistency and consistency of the judgment.

Nowadays, EC has been used in many areas and it gives an excellence result to solve many problems. It also happens in this paper when EC give an excellent result in deriving priorities in AHP.

The advantages of using EC in AHPEC are:

1. EC does not have much mathematical requirements about the optimization problems. EC can handle any kind of objective functions and any kind of constraints (linear or nonlinear), defined on discrete, continuous or mixed.
2. By using EC, with single optimal run, the optimal solution can be found.
3. EC provides adaptability and give a good performance in solving the problem as shown in Table 4 and Table 5.

4 Web-based Decision Support System

Decision Support System (DSS) is interactive computer-based systems, which help decision makers utilize data and models to solve unstructured problems [26]. Keen and Scott Morton [27] defines DSS couple the intellectual resources of individual with the capabilities of the computer to improve the quality of decisions. It is a computer-based support system for management decision makers who deal with semi structured problems. Another definition, Little [28] say DSS is a model-based set of procedures for processing data and judgments to assist a manager in his decision-making. Therefore, there is no universally accepted definition of DSS.

Since the explosion of World-wide Web and global Internet has been growing day to day, the DSS can be built in web-based environment. Web-based DSS (WDSS) is giving more support of technology platform for further extending the capabilities and deployment of computerized decision support.

WDSS is to provide a way for storing, presenting, gathering, sharing, processing, and using information [29]. The WDSS also provide information processing, interaction, and tool with user-friendly interface. By using WDSS, it allows users to access system at anytime and anywhere. Figure 11 shows the architecture component of WDSS.

Based on figure 11, the proposed method will be used to represent a model in a prototype of Web-based DSS (WDSS) for future study.

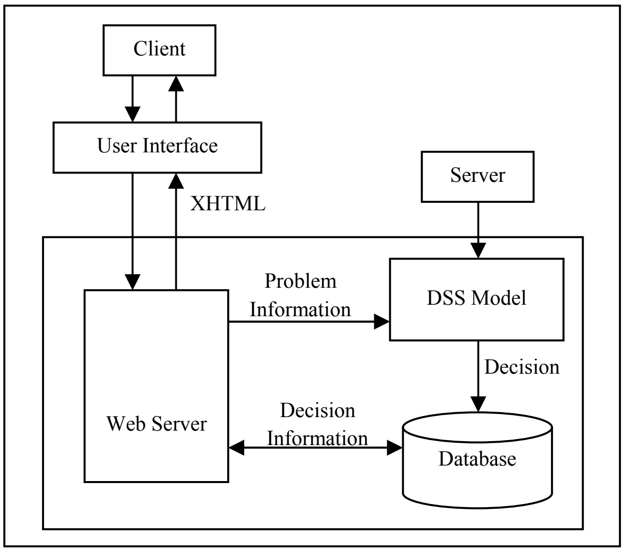

Figure 11: The architecture component of web-based DSS
(adopted from Turban and Aronson [1])

5 Conclusion

This paper proposed AHPEC as an approach to derive priorities in AHP. This paper solving single objective optimization problem, by maximizing accuracy of the solution and it is using Total Deviation (TD) as criterion. AHPEC gives much better result compared to the other non-EC prioritization methods. From the experiment that has been done, we can conclude that AHPEC is more adaptable, accurate, and flexible. This feature enables it to be applied to all case studies.

For the further research, the design and development of the prototype will be done to demonstrate the practicability of AHPEC and it is web-based Decision Support System (WDSS).

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