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Designing of garment by Similarity Measures on Fuzzy Sets

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Abstract

Measuring between objects is important for simulation. One application of simulating is in designing garment where we want to compare some patterns with a given pattern evaluated by expert. The similarity measures between fuzzy sets can be a solution for this case. In this paper there is a database that contains 30 patterns of clothes with 6 features. So the possible cases from combination of these patterns are 30^6 that is enormous. First of all 30 patterns were shown to experts for evaluation that contained all possible properties. They were asked to report truth and false membership functions by making them into intuitionistic fuzzy set (*IFS*).These values for each element is between 0 and 1. Then the similarity between new pattern and the patterns which were evaluated by experts could be found. After that the fitness value for new pattern was estimated. Our result showed this method was successful in measuring similarity between two fuzzy items.

Keywords: Similarity Measures, Fuzzy Sets, Garment designing

1. Introduction

The theory of fuzzy set, proposed by Lotfi Zadeh in 1965 [1], has obtained a lot of success in different fields. The generalization of fuzzy sets is Intuitionistic fuzzy sets (IFSs) that was introduced by Atanassov in 1986-1999[1].There are a lot of applications in measuring similarity between IFSs such as data preprocessing and data mining [1]. Also IFSs have been widely applied in a variety of areas such as logic programming that is done in 1990 by cf. Atanassov and Gargov [2] and in decision making problems in1993byAtanassov and Georgeiv[2] and also in 1996 by Szmidt andKacprzyk, and in medical diagnostics in 2001that is done by Deet etc[2]. In 2002 Li and Cheng discussed similarity measures on IFSs and used it in pattern recognition problems [2] .Another application of IFSs is in medicine. Zhang and Fu in 2006 [2] utilized this method in a research about the colorectal cancer [2]. In garment industry the comparison with experts opinion has a very significant role. So in this research the similarity between fuzzy sets is applied to compare the pattern of garment that has similarity in elements with the pattern which is evaluated by experts. But first it is necessary to generate patterns. In this part the genetic algorithm is applied. This is a method of searching in database which is inspired by the nature and based on repetition. In 2000 Kim et al. proposed the system of designing fashion that

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used the native style of clothes based on a new way of encoding [3]. Another study in 2006 by Gong, Hao , Zhou and Sun was a multi-population adaptive hierarchy and their application in fashion design [4]. There are some other researches in textile industry such as optimization of pattern layout considering multi set pattern &pieces rotation [5]. And also designing of weaving fabric by genetic algorithm [6]. And also an application of IGA for generating carpet pattern [7]. In this paper after generating pattern by genetic algorithm the similarity between fuzzy sets is used for improving genetic algorithm.

2. Methodology

In this part the method of the research, which includes genetic algorithm and fuzzy similarity measure will be explained. Genetic algorithm is a system developed on the basis of evolutionary method which is driven from Darwin's theory. Algorithm begins with producing chromosomes and coding as an initial population. Then the fitness values are identified by fitness function in genetic algorithm or by user in interactive genetic algorithm (IGA). The best chromosomes are selected as parents. Then GA operators such as copy crossover and maturation take action. After that the convergence of system should be investigated. If it converges to the desirable solution, the process is over. Otherwise, the process should be repeated. As it was mentioned before, in IGA user must identify fitness value but it is impossible to show all patterns to him or her for evaluation and this is one of the difficulties of IGA. In this research, the fitness of other patterns was determined by the similarity between fuzzy sets. The algorithm of this system is shown in Figure 1. In fact, the user evaluates a part of population and the other population is evaluated by similarity between fuzzy sets. After finding the fitness of all population, these values must be equal to each other - that will be explained in section 4 .

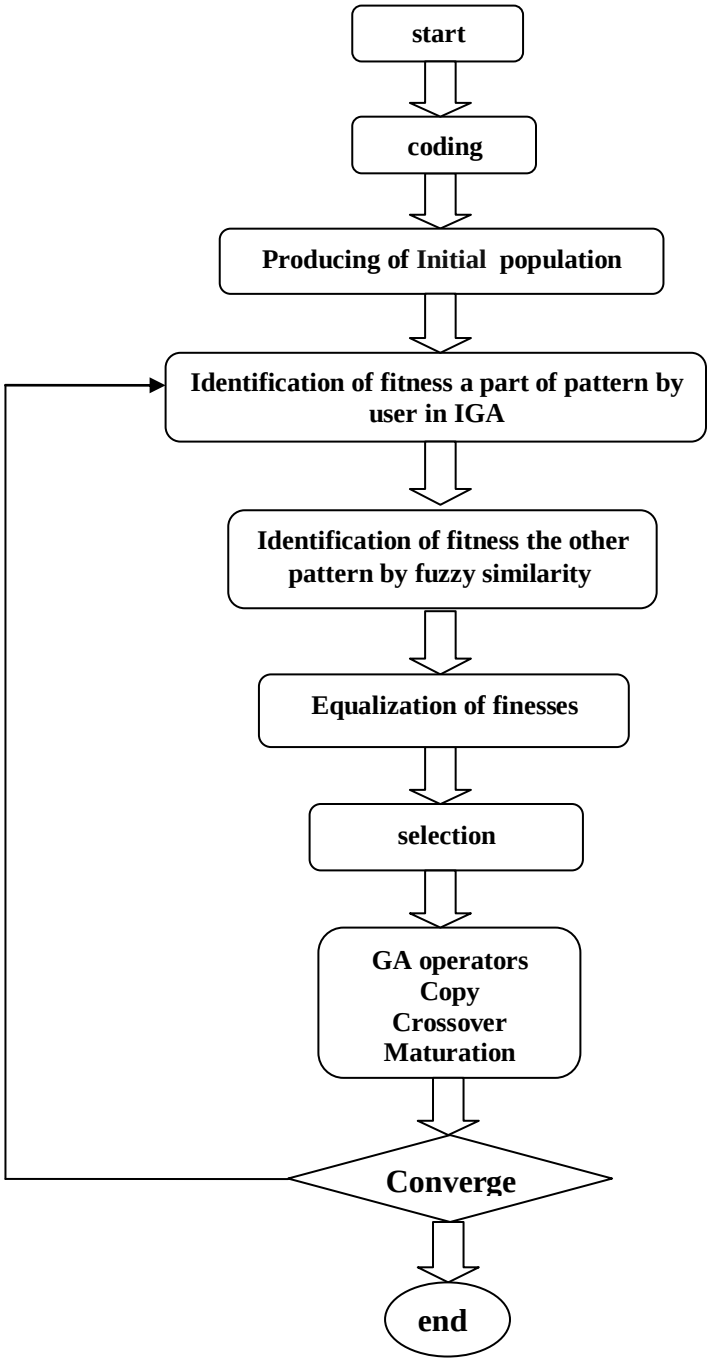

Figure1. The structure of designing Iranian women's dress

3. Intuitionistic fuzzy sets (IFSs) and Similarity Measures

In this part the IFSs and their properties will be explained. An intuitionistic fuzzy set (IFS) A in X is defined as follow:

$A = \{x, t_A(x), f_A(x) | x \epsilon X\}$ (1)

$$t_x: X \to [0,1] \quad f_x : X \to [0,1] \tag{2}$$

In this definition, X is universe of discourse, t_x is truth-membership function and f_x is false membership function and the relation between them is:

$$t_x + f_x \leq 1 \tag{3}$$

Two fuzzy sets A, B are defined like this

$$B = \sum_{i=1}^{n} [t_B(x_i), 1 - f_B(x_i)] \ /x_i \tag{4}$$

$$A = \sum_{i=1}^{n} [t_A(x_i), 1 - f_A(x_i)] \ /x_i \tag{5}$$

The similarity between two fuzzy sets is calculated as fallow:

$$S(A,B) = \frac{1}{n}\sum_{i=1}^{n} M\ (V_A(x_i), V_B(x_i) \tag{6}$$

$$S(A,B) = \frac{1}{n}\sum_{i=1}^{n} \ 1 - (\frac{(|\delta_A(x_i) - \delta_B(x_i)| + |\alpha_A(x_i) - \alpha_B(x_i)}{2})| \tag{7}$$

$$S(A,B) = 1 - \frac{1}{2n}\sum_{i=1}^{n} (|\delta_A(x_i) - \delta_B\ (x_i)| + |\alpha_A(x_i) - \alpha_B(x_i)| \tag{8}$$

Where

$$T \tag{9}$$

$$\delta_x = t_x + T_x t_x \tag{10}$$

$$\alpha_x = f_x + T_x f_x \tag{11}$$

4. Designing garment

In this research 30 patterns of Iranian women dress is prepared and each pattern has 6 elements such as collar, sleeve, skirt, belt, button, and pocket. In fact all possible combinations from these patterns is 30^6.This amount of data is so enormous for evaluation and makes users' tired. In this system just 8 pictures is shown to user for evaluation and the rest of evaluation is done by Similarity Measures between fuzzy sets. Note that selecting 8 pictures is just for picture preciosity.

At the beginning 30 patterns that have all possible properties were shown to 60 experts for evaluation. They were asked to report two numbers, one ranging between [0, 5] that will be transformed to t_x later and another is general opinion about each pattern called fitness value which is between [0, 1]. t_x is defined as the simplicity of

each elements such as collar, sleeve,... and f_x is the opposite of t_x , which means it is fashionable. In fact each expert reports a number between [0, 5] that zero means the most simplistic elements and 5 is the most fashionable element. This number will be transformed to t_x by following formula:

(12)

$$t_x = \begin{cases} 1 & 0 \le x \le 2.5 \\ -0.4x + 2 & 2.5 \le x \le 5 \end{cases}$$

This function means degree of simplicity is 1 and then it decreases until that is never simple. If one element doesn't exist, for example there is no pocket or button for a dress, the t_x value is assumed zero that means this element was simple. As it was mentioned before:

$$f_x = 1 - t_x \quad (13)$$

For a new pattern t_x and f_x can be found based on their elements. Then the similarity between the new pattern and 30 patterns that their fitness was determined before by user was found. For identifying the fitness value of the new pattern, the most similar pattern was selected and fitness value was multiplied by the similarity value in fitness value of the most similar pattern. By this way, the fitness of those patterns that weren't shown to user in IGA can be found. After this process, the fitness values which are obtained from user evaluation and similarity fuzzy must be equaled. For this reason, all the data should be subtracted from minimum of data and divided to maximum of data.

5 .Experiments and result

For comparing the simple IGA and IGA with similarity fuzzy modification, the observers were asked to use this system. The fitness values which are obtained from user, are collected in six groups, each group contains 10 data. The age of the users was ranged from18 to 25 years. Every person runs this system in 9 generation. The average of satisfaction degree among 9 generations was explored. The difference between the two procedures is shown in Figure 2 and 3. It was seen that the distribution of fitness degree in simple IGA is so irregular but in IGA with similarity fuzzy modification fitness degree increased in last generations. Also the percentage of satisfaction among the generation in IGA with similarity fuzzy modification is shown in figure 4. In fact this diagram show where each user get satisfied with this system.

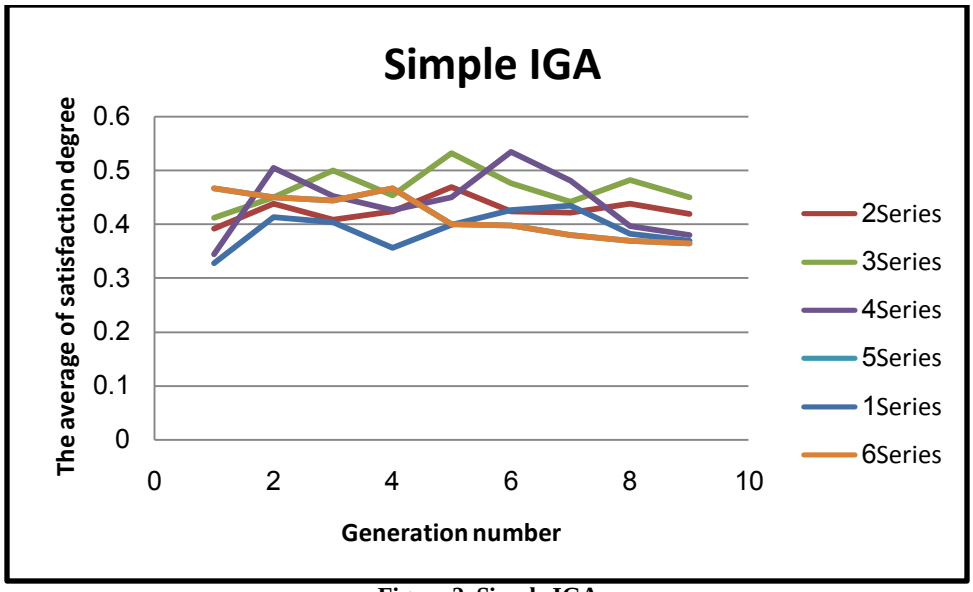

Figure 2. Simple IGA

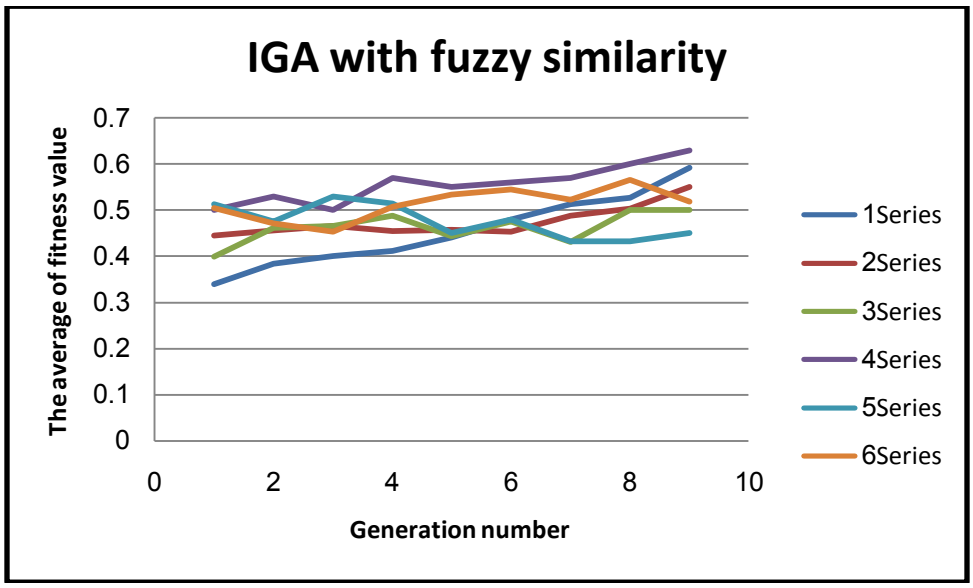

Figure 3. IGA with similarity fuzzy modification

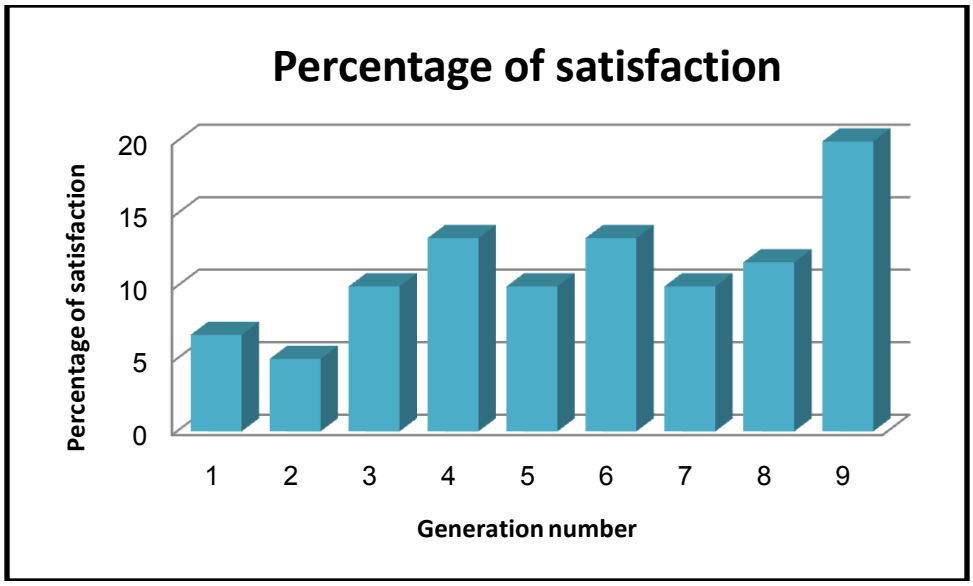

Figure 4. The percentage of satisfaction

6. Conclusions

In this research a fashion designing system with fuzzy similarity modification was presented. In this system IGA was applied for producing and evaluating some patterns and fuzzy similarity was applied for evaluation of other patterns. Our results showed that this system can perform effectively in fashion design. The performance of IGA fuzzy similarity system is much better than simple IGA. Some advantages of this system are saving time and money, creating different and unpredictable patterns, developing a system based on user preferences.

7. References

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