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Fuzzy-Genetic Approach for Erectile Dysfunction

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Abstract

Erectile dysfunction is a medical problem. Most of the approaches applied in diagnosis are subjective in nature, with none geared toward soft-computing approach application. Fuzzy-Genetic approaches will help handle both imprecision and vagueness. Our model was interactive in nature while the simulation results utilizing Matrix Laboratory (MATLAB) was satisfactory. This paper demonstrates the practical application of soft computing techniques in medical diagnosis in determining patient's satisfaction.

Keywords: Erectile Dysfunction, Genetic Algorithm, Fuzzy Logic, Fuzzy-Genetic System.

1.0 Introduction

Erectile Dysfunction (ED) could be defined as the inability to get or keep an erection firm enough for sexual intercourse [1 - 3]. ED can be a total inability to achieve an erection, an inconsistent ability to do so, or a tendency to sustain only brief erections. ED is sometimes called impotence, but that word is being used less often so that it will not be confused with other, nonmedical meanings of the term. It is normal for men to occasionally experience erectile dysfunction. . Doctors consider erectile dysfunction to be present if attempts at intercourse fail at least 25% of the time. However, if the problem becomes chronic, it can have adverse effects on relationships, emotional health, and self-esteem [2]. The ability to achieve and sustain erections requires [1]: Healthy nervous system that conducts nerve impulses in the brain, spinal column, and penis, Healthy arteries in and near the corpora cavernosa, Healthy smooth muscles and fibrous tissues within the corpora cavernosa, and adequate levels of nitric oxide in the penis. Erectile dysfunction can occur if one or more of these requirements are not met. The following are causes of erectile dysfunction [3]:

a. **Aging**: There are two reasons why older men are more likely to experience erectile dysfunction than younger men. First, older men are more likely to develop diseases (such as heart attacks, cardiovascular disease, strokes, diabetes mellitus, and high blood pressure) that are associated with erectile dysfunction. Second, the aging process alone can cause erectile dysfunction in some men, primarily by decreasing the compliance of the tissues in the corpora cavernosa, although it has been suggested, but not proven, that there is also decreased production of nitric oxide in the nerves that innervate the corporal smooth muscle within the penis.
b. **Diabetes mellitus**: Erectile dysfunction tends to develop 10-15 years earlier in diabetic men than among non-diabetic men. The increased risk of erectile dysfunction among men with diabetes mellitus may be due to the earlier onset and greater severity of atherosclerosis that narrows the arteries and thereby reduces the delivery of blood to the penis. When insufficient blood is delivered to the penis, it is not possible to achieve an erection. Diabetes mellitus also causes erectile dysfunction by damaging both sensory and autonomic nerves, a condition called diabetic neuropathy. Smoking cigarettes, obesity, poor control of blood glucose levels, and having diabetes mellitus for a long time further increase the risk of erectile dysfunction in diabetes.
c. **Hypertension (high blood pressure)**: People with essential hypertension or arteriosclerosis have an increased risk of developing erectile dysfunction. Essential hypertension is the most common form of hypertension; it is called essential hypertension because it is not caused by another disease (for example, by kidney disease). It is not clearly known how essential hypertension causes erectile dysfunction; however, those with essential hypertension have been found to have low production of nitric oxide by the arteries of the body, including the arteries in the penis.
d. **Cardiovascular diseases**: The most common cause of cardiovascular diseases in the United States is atherosclerosis, the narrowing and hardening of arteries that reduces blood flow. Atherosclerosis typically affects arteries throughout the body and is aggravated by hypertension, high blood cholesterol levels, cigarette smoking, and diabetes mellitus. When coronary arteries (arteries that supply blood to the heart muscle) are narrowed by

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atherosclerosis, heart attacks and angina occur. **Cigarette smoking**: Cigarette smoking aggravates atherosclerosis and thereby increases the risk for erectile dysfunction.

e. **Nerve or spinal cord damage**: Damage to the spinal cord and nerves in the pelvis can cause erectile dysfunction. Nerve damage can be due to disease, trauma, or surgical procedures. Examples include injury to the spinal cord from automobile accidents, injury to the pelvic nerves from prostate surgery for prostate cancer (prostatectomy), radiation to the prostate, surgery for benign prostatic enlargement, multiple sclerosis (a neurological disease with the potential to cause widespread damage to nerves), and long-term diabetes mellitus.

f. **Substance abuse**: Marijuana, heroin, cocaine, methamphetamines, crystal meth, and alcohol abuse contribute to erectile dysfunction. Alcoholism, in addition to causing nerve damage, can lead to atrophy (shrinking) of the testicles and lower testosterone levels.

g. **Low testosterone levels**: Testosterone (the primary sex hormone in men) is not only necessary for sex drive (libido) but also is necessary to maintain nitric oxide levels in the penis. Therefore, men exhibiting hypogonadism (diminished function of the testes resulting in low testosterone production) can have low sex drive and erectile dysfunction.

The predominant symptoms of erectile dysfunction include:

a. Includes Inability for regular erection,
b. Persistent pain around the penis,
c. Inadequate nitric oxide in the penis
d. Lack of smooth muscles and fibrous tissues
e. Unhealthy arteries around the corpora

The main focus of this research is gear towards projecting a Genetic fuzzy system capable of predicating erectile dysfunction utilizing a model based approach.

2.0 Review of Related Literature

A rat model for recognition for male erectile dysfunction was proposed in 2008 [4]; their aim was based on review the most common laboratory techniques that employ rat model for the evaluation of male erectile function and erectile tissue end-organ analyses. Their methods were based on peer-reviewed literature. The main outcome was pathophysiology and laboratory research outcome correlation. Their results suggest that rat is a versatile model in sexual medicine research. In conclusion versatile model should help in the further development of research tools, characterize additional signaling target molecules and pathways, and help in our understanding of male sexual dysfunction.

Several research work and model has proposed and implemented on erectile dysfunction, but only a hand-full has been focused on soft-computing paradigms on this hunt this research is inspired.

The theory of fuzzy logic provides a mathematical strength to capture the uncertainties associated with human cognitive processes, such as thinking and reasoning. In standard set theory, an object does or does not belong to a set. There is no middle ground. In such bivalent systems, an object cannot belong to both its set and its compliment set or to neither of them. This principle preserves the structure of the logic and avoids the contradiction of object that both is and is not a thing at the same time [5]. However, fuzzy logic is highly abstract and employs heuristic (experiment) requiring human experts to discover rules about data relationship [6].

Fuzzy classification assumes the boundary between two neighboring classes as a continuous, overlapping area within which an object has partial membership in each class [7]. Fuzzy logic highlights the significant of most applications in which categories have fuzzy boundaries, but also provides a simple representation of the potentially complex partition of the feature space [1, 8]. The complexity and limitations of previous mechanisms are largely due to the lack of an effective way of defining the boundaries among clusters. This problem becomes more intractable when the number of features used for classification increases [10].

The Genetic Algorithm (GA) is a search and optimization technique [7] based on the principles of genetics and natural selection. They represent processes in nature that are remarkably successful at optimizing natural phenomena. They are capable of solving other types of problems, using genetic operators abstracted from nature; they form a mechanism suitable for a variety of search problems. These algorithms encode a potential solution to a specific problem on a simple chromosome-like data structure and apply recombination operators to these structures so as to preserve critical information. Genetic algorithms are often viewed as function optimizer. The main idea is survival of the fittest (natural selection). Genetic algorithm is composed of three main genetic operators namely; **Selection:** is a way for the genetic algorithm to move toward promising regions in the search space. **Mutation:** is a genetic operator that changes one or more gene values in a chromosome. The mutation process helps to overcome trapping at local maxima. **Crossover:** Exchanging Chromosomes portions of genetic materials.

3.0 Methodology, Design and Result

From the review of erectile model approaches, the following drawback has been elicited. Most of the implemented approaches are subjective [4] in nature therefore an objective approach is necessary. Soft-computing approach to the best of our knowledge has not been explored in this region.

Our methodology is tied to two approaches

a. Proposing our soft-computing model utilizing soft-computing components.
b. Model functionality specified with set theory classification.

3.1 The Proposed Genetic-Fuzzy Model

The proposed model is an architectural framework which enhances the fuzzy (inexact) of diagnosis associated with erectile dysfunction. Unlike the current approaches, in which success or failure are based on the wills and experiences of the medical professional. This model is artificial intelligence based; therefore success and failure are not dependent on human intuitions, but success, is closely linked within tuned-up approaches within the system components.

The model is presented in figure 1

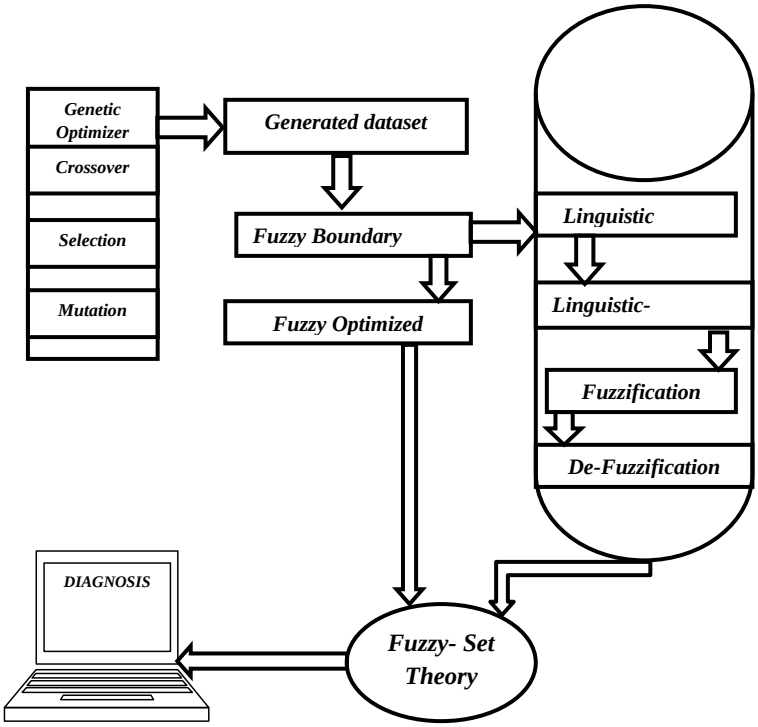

Figure 1: Genetic-Fuzzy Model for Erectile Dysfunction

a. The genetic optimizer help the model arrive at a universal boundary point for high and low membership function deductions utilizing the genetic operator selection, crossover and mutation in optimizing the generated membership function reside within the knowledgebase.
b. The knowledgebase hold the health care satisfaction criteria's, the generated membership function elicited from relevant questionnaires distribution and tuning and the fuzzy –if –then rules.
c. The inference engine which is the heart of the model utilizing fuzzy operators; fuzzification and defuzzification to draw inference based on the generated membership function and fuzzy if then rules. There is a two-way interaction between the knowledge base and the inference engine enabling objective output to be obtained.
d. The diagnosis components display output results.

Table 1: *Data Set showing the Degree of membership for Erectile Dysfunction*

Parameters or Fuzzy sets For Erectile Dysfunction	**Codes**	**Membership Function for Erectile Dysfunction**		
		Cluster 1 (C_1)	**Cluster 2 (C_2)**	**Cluster 3 (C_3)**
Inability for regular erection,	R01	0.50	0.15	0.35
Persistent pain around the penis,	R02	0.20	0.20	0.60
Inadequate nitric oxide in the penis	R03	0.10	0.80	0.10
Lack of smooth muscles/fibrous tissues	R04	0.20	0.10	0.70
Unhealthy arteries around the corpora	R05	0.30	0.60	0.10
Regular Vomiting	R06	0.05	0.05	0.90
Waist pain	R07	0.00	0.50	0.50

Table 2: *1st and 2nd Generation Table*

Codes	**Selection**	**Chromosomes (Binary; 0 or 1)**			**Fitness function**
		Parent (1st Gen)	**Crossover**	**Parent (2nd Gen)**	
R01	50	110010	1 & 6	**110**101	**53**
R02	46	101110	2 & 4	**101**100	**44**
R03	46	101110	Mutation	1011**0**0	**44**
R04	44	101100	2 & 4	**101**110	**46**
R05	38	100110	5 & 7	**100**010	**34**
R06	37	100101	1 & 6	**100**010	**34**
R07	18	010010	5 & 7	**010**110	**22**
Fuzzy membership Function Boundary					**0.53**

3.2 Result

Matrix Laboratory (MATLAB) serves as our simulation tool in achieving the our results because of its interactive environment for algorithm development, data visualization, data analysis, and numerical approach which was relevant to our numerical dataset which was more appropriate than with spreadsheets or traditional programming languages, such as C/C++ or Java. The generated results in table 3 were achieved utilizing 0.53 for determining high degree membership function and low degree membership function. The fuzzy partition for each input feature consists of the parameters for diagnosing erectile dysfunction. The fuzzy rules that can be generated from the initial fuzzy partitions are thus:

a. Not Diagnosed with erectile dysfunction (Class: C_1)
b. Moderately Diagnosed with erectile dysfunction (Class: C_2)
c. Diagnosed with erectile dysfunction (Class: C_3)

If the patient (P) experiences less than or equal to two ($P \leq 2$) of the parameters for erectile dysfunction *THEN* (C_1), If the patient (P) experiences three ($P = 3$) of the parameters for erectile dysfunction *THEN* (C_2) If the patient (P) experiences four ($P \geq 4$) or more parameters for erectile dysfunction *THEN* (C_3).

Table 3: *Data Set showing the Degree of membership Erectile dysfunction*

Parameters or Fuzzy sets For Erectile Dysfunction	**Codes**	**Membership Function for Erectile Dysfunction**		
		Cluster 1 (C_1)	**Cluster 2 (C_2)**	**Cluster 3 (C_3)**
Inability for regular erection,	R01	0.50	0.15	0.35
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Lack of smooth muscles/fibrous tissues	R04	0.20	0.10	0.70
Unhealthy arteries around the corpora	R05	0.30	0.60	0.10
Regular Vomiting	R06	0.05	0.05	0.90
Waist pain	R07	0.00	0.50	0.50
Diagnosis Result		***Not Diagnosed with erectile dysfunction***	***Moderately Diagnosed with erectile Dysfunction***	***Diagnosed with erectile Dysfunction Diagnosed with erectile dysfunction (Class: C3)***

Table 3 represents the degree of membership function for customer relationship management, for instance, R05 in cluster 1, we notice it has 0.30. In percentage, it can be represented as 30%, in cluster 2, 60%, in cluster 3, 10%. This means that the degree of membership function for erectile dysfunction of P05 matches **30% of *Not Diagnosed with erectile dysfunction*, 60% of *Moderately Diagnosed with erectile Dysfunction*** and **10% of *Diagnosed with erectile Dysfunction*.** The Fuzzy clustering graphical distribution shown Figure 2 depicts one criterion with high degree of membership function for ***Not Diagnosed with erectile dysfunction,*** three criteria's with high degree of membership function of ***Moderately Diagnosed with erectile Dysfunction***, four criteria's with high degree of membership function of***Diagnosed with erectile Dysfunction*.**

Fuzzy set Range (0-1)

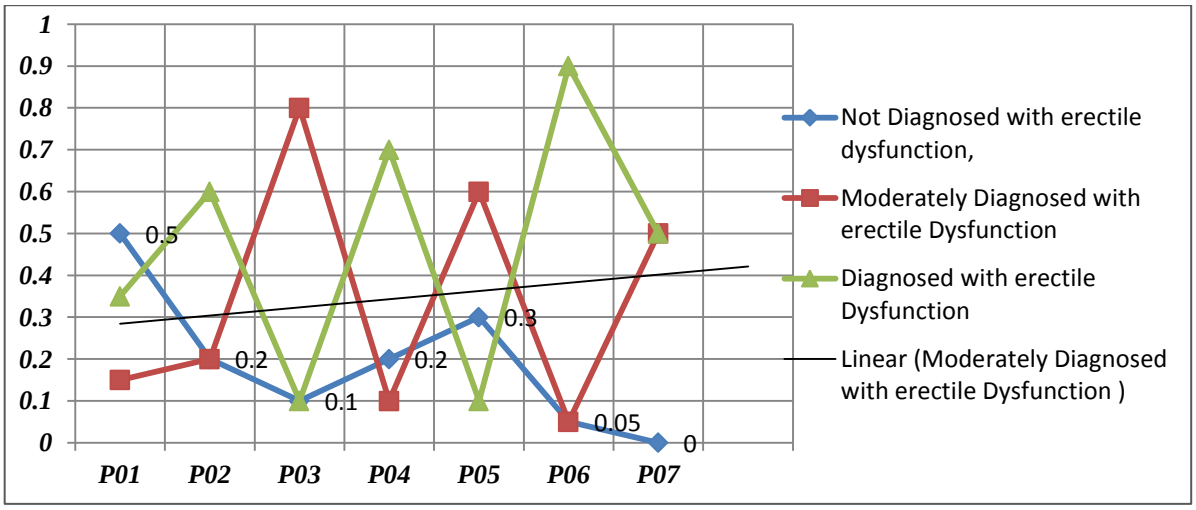

Fig. 2: *Graphical Representation highlighting the Degree of Membership Function*

4.0 Discussion

Genetic fuzzy Model provides an interactive framework of determining erectile dysfunction objectively as opposed to the subjective approach. This is achievable utilizing our model which is an hybrid approach in nature handling imprecision associated with criteria's for identifying erectile and optimizing these criteria's to pinpoint a central base for determining linguistic variables membership function in achieving our fuzzy middle-ground ("Moderately diagnosed") from "Not Diagnosed" and "Diagnosed". This approach has help solved the problem associated previously approaches.

5.0 Conclusions

This paper has demonstrates the practical application of soft computing in the medical sector in determining diagnosis erectile dysfunction. This model which uses a set of fuzzified data set incorporated and optimized by genetic algorithm is more precise than the traditional system. The system designed is an interactive system which specifies patient ranges of diagnosis.

6.0 References

[1] Healthline (2014), "Erectile Dysfunction" retrieved from Healthline.com

[2] MedicineNet (2014), "Erectile Dysfunction" retrieved from MedicineNet.com

[3] RightDiagnosis (2014), "Erectile Dysfunction" rightdiagnosis.com

[4] Mehta N., Sikka S, Rajasekaran M. (2008), "Rat as an animal model for male erectile function xual medicine research", retrieved online from http://www.ncbi.nlm.nih.gov/pu.

[5] Zadeh L.A. (1965), "Fuzzy sets. Information and Control", Vol.8, pp.338-353.

[6] Angel C. and Rocio R. (2011), "Documentation management with Ant colony Optimization Metaheuristic: A Fuzzy Text Clustering Approach Using Pheromone trails" retrieved from soft computing in Industrial applications, Advances in intelligent and soft Computing, vol. 96, 2011, 261-70, DOI: 10.1007/978-3-642-20505-1_23.

[7] Kuang Y. H.; Ting-H. C. and Ting-Cheng Chang (2011),"Determination of the threshold value β of variable precision rough set by fuzzy algorithms" retrieved from http://www.sciencedirect.com/science/article/pii/S0888613X11000831

[8] Sun C.T. and Jang J.S. (1993) "A Neuro-Fuzzy Classifier and its Applications", in: Proc. IEEE Int. Conference on Neural Networks, San Francisco, pp.94–98.

[9] Ahmad H. (2011), "Fuzzy approach to Likert Spectrum in Classified levels in surveying researches" retrieved http://www.tjmcs.com.

[10] Christos S. and Dimitros S. (2008) "Neural Network", retrieved from http://www.docstoc.com/docs/15050/neural-networks