Design of NeuroFuzzy system for multivariable blood pressure control

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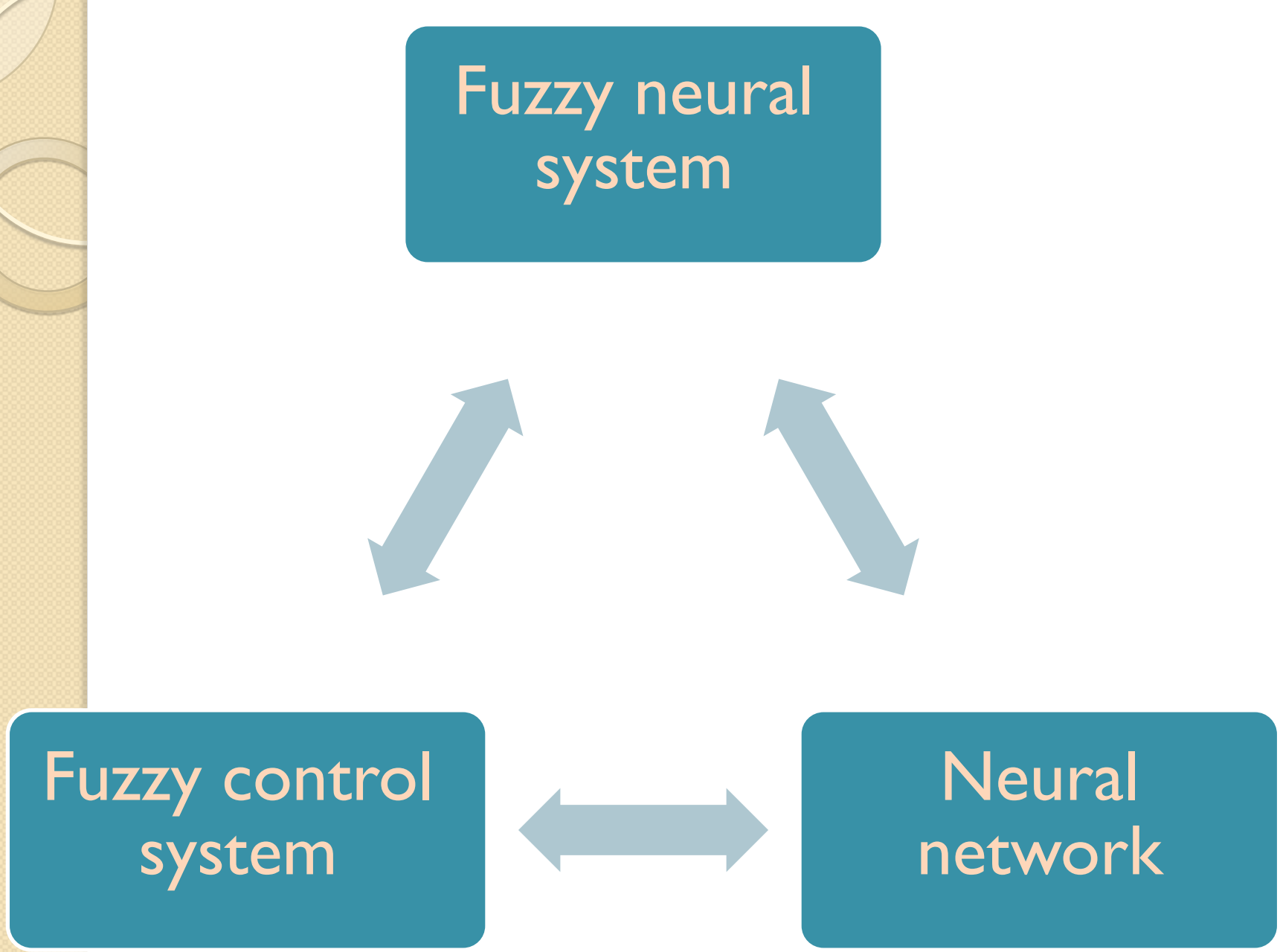
Introduction

Blood pressure is a difficult mechanism to be regulate manual, so this research based on an automatic method to solve that problem, by using proposed system, which include combination of both of neural network and fuzzy logic control systems.


Fuzzy neural system
Fuzzy control system
Neural network

Problem statement

If blood pressure is controlled, patients experience fewer complications after surgery. In clinical practice, this is usually achieved using manual drug delivery, various automatic control techniques have been used to control the hemodynamic variables by infusion of two agent, (dpm) and (snp). Given that different patients have different sensitivity and reaction time to drugs, determining manually the right drug infusion rates may be difficult. This is a problem where automatic drug delivery can provide a solution.

Objectives

The objectives of this research are to:

-Introduce various design approaches for the purpose of multivariable control applications.

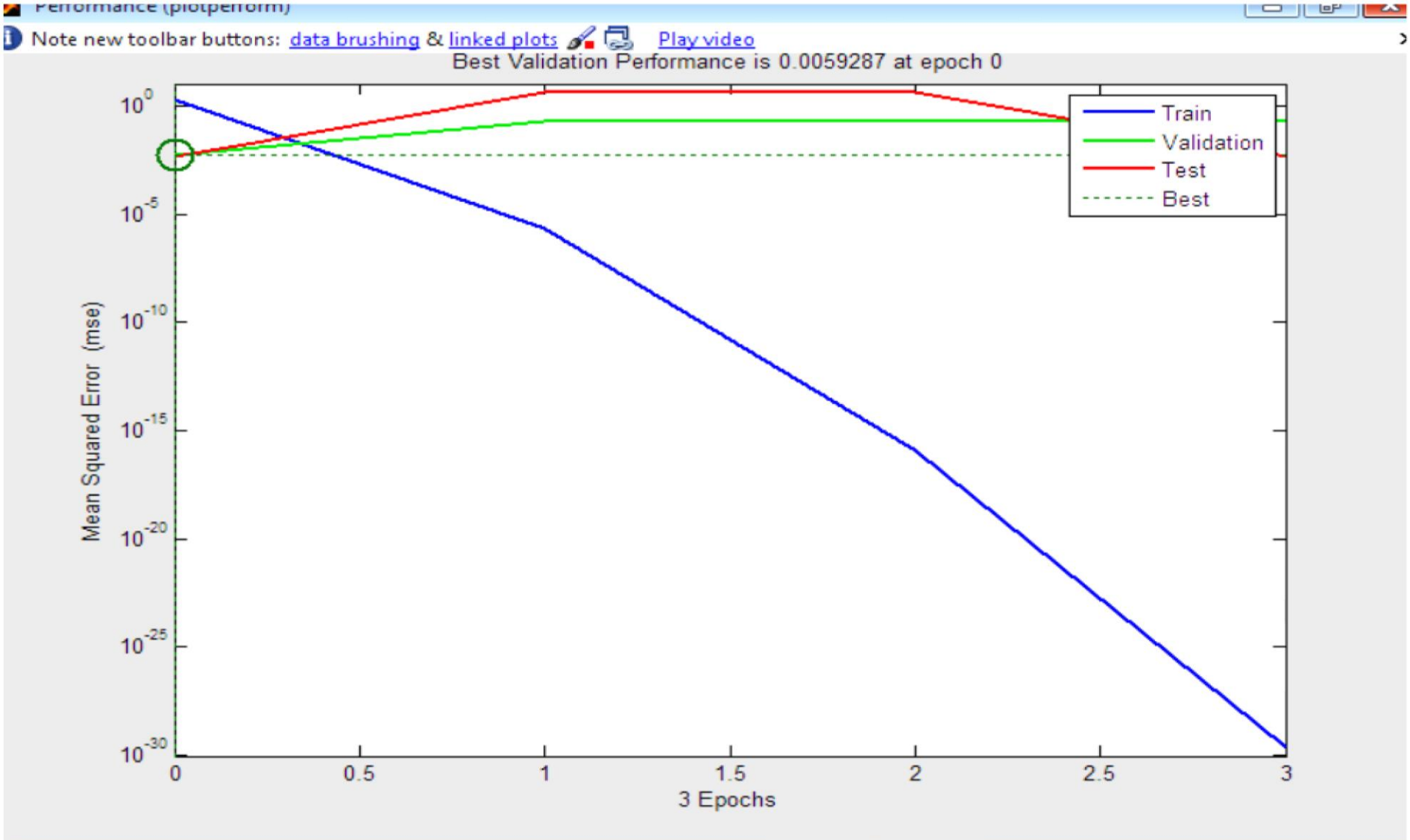
-Control blood pressure by infusion the DPM and SNP to regulate the hemodynamic variables automatically.

-Present the beneficiary application of artificial intelligent in the medical field.

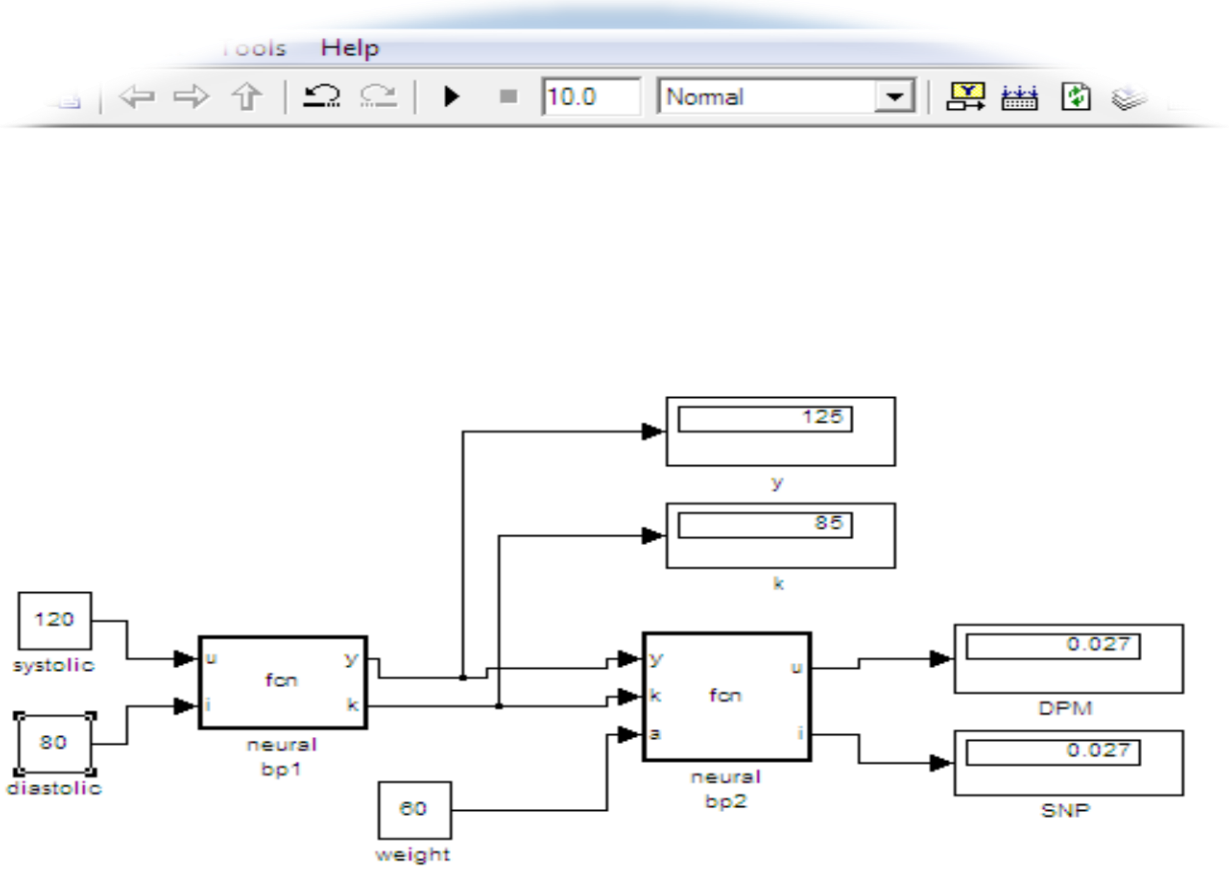
The Methodology

A proposed system consist of two steps, In the first step, neural network (back propagation), was be applied, first: input [78 90 125 145 165;58 68 85 95 105] and target [20 15 0 8 12], be inserted to network, after numbers of training process , an acceptable outputs was obtained [19.5579 15.0692 0.0270 8.0734 11.7944], with minimum error (10^-30).

Training network error



Simulation of neural network



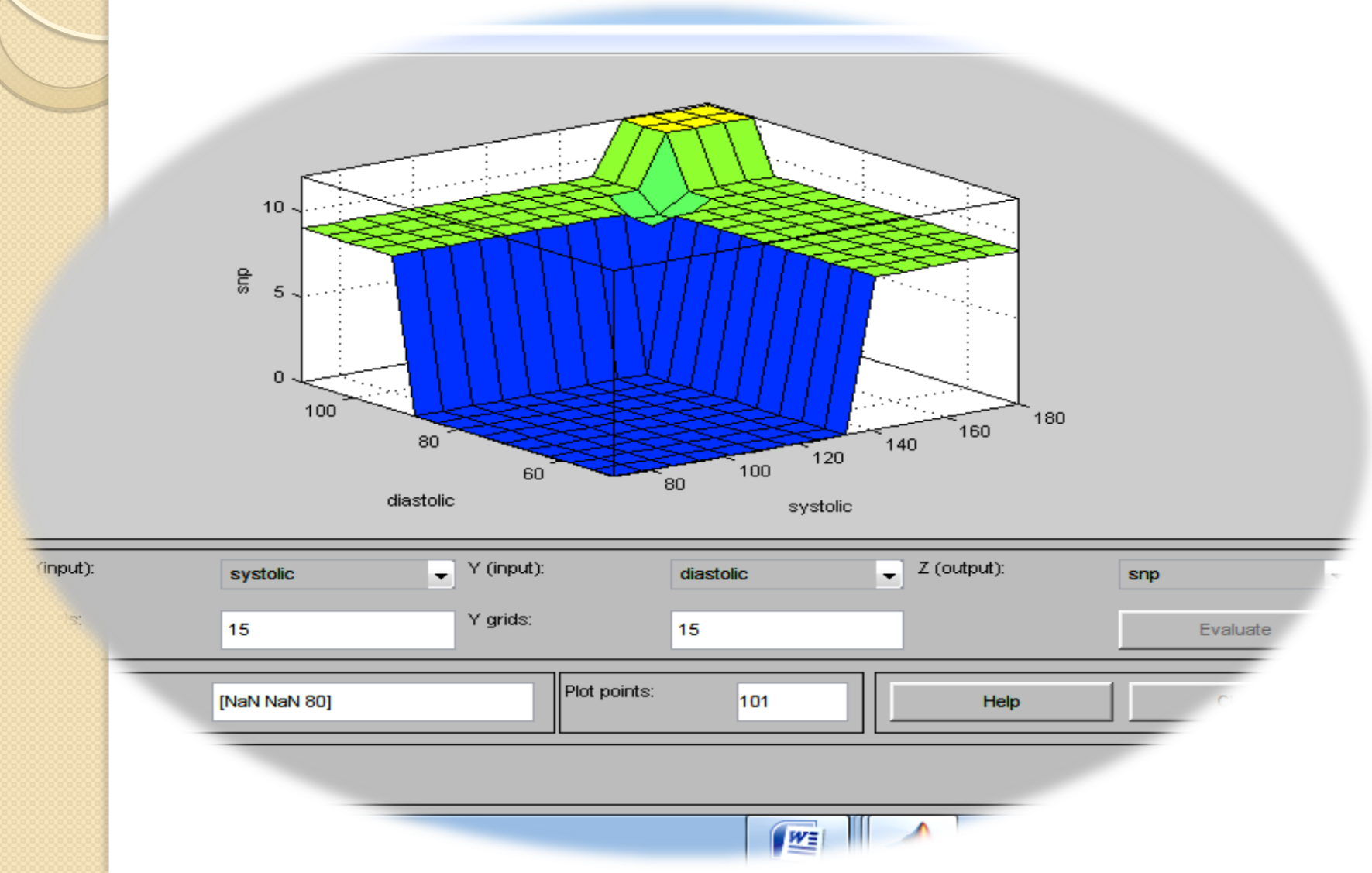
Samples of blood pressure network results:

weights	Very low	low	normal	high	Very high
45	11.5579	8.0692	0.0270	4.5734	6.7944
55	13.5579	10.0692	0.0270	5.5734	7.7944
60	15.5579	10.5692	0.0270	6.0734	8.7944
75	19.0579	13.0692	0.0270	7.5734	10.7944
80	20.5579	14.0692	0.0270	8.0734	11.7944
95	24.5579	17.0692	0.0270	9.5734	13.7944
115	29.5579	21.0692	0.0270	11.5734	16.7944

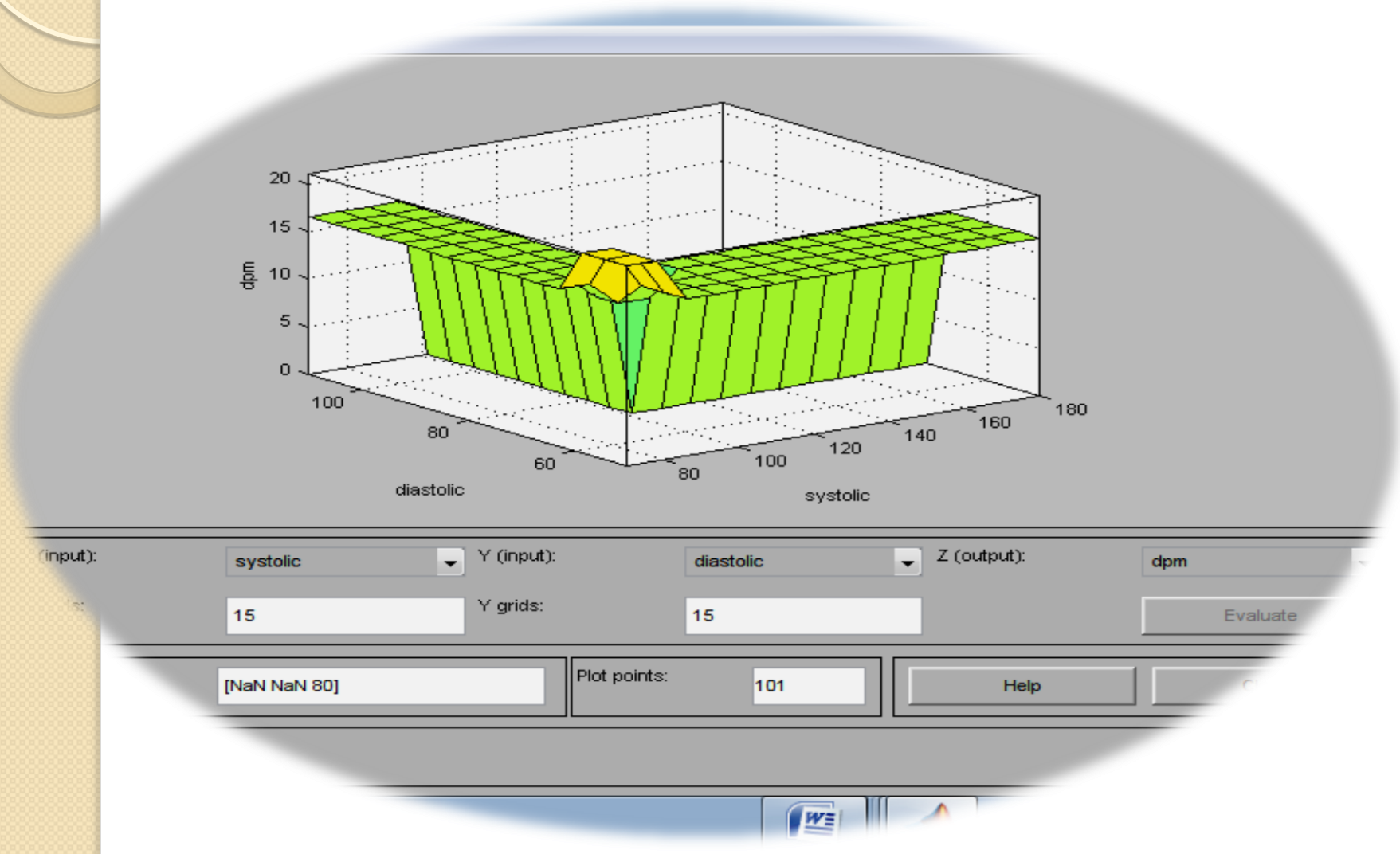
Fuzzy logic control:

In the second step, fuzzy control system was be applied, for both of hypertension and hypotension, which each one of them consist of four linguistic variables, that consists of numbers of fuzzy sets. Then rules of fuzzy logic was created in different cases of linguistic variables, example: IF fuzzy set (1) and fuzzy set (2) and fuzzy set (3) THEN fuzzy set (4).

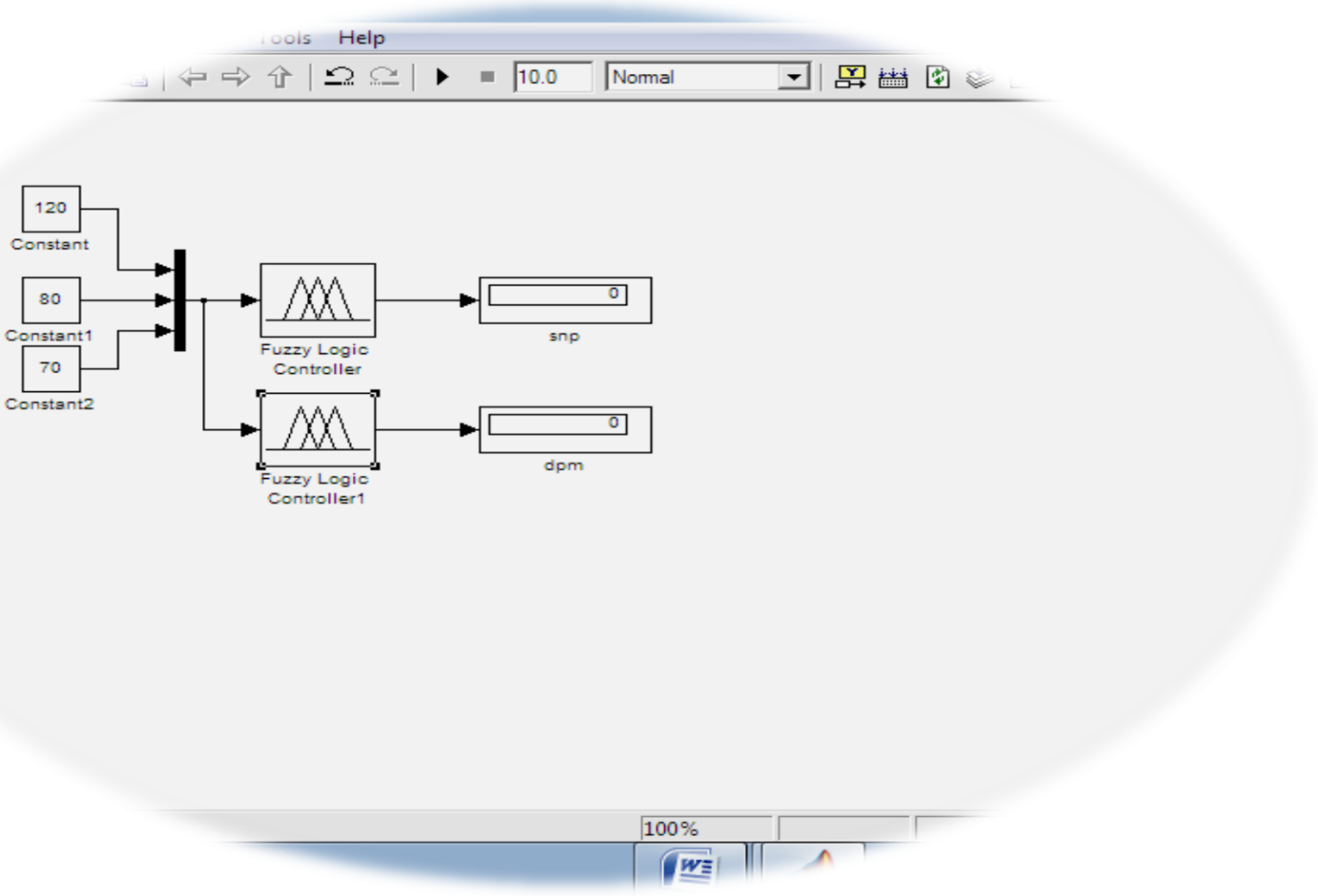
Rules of hypertension cases:



Rules of hypotension cases:



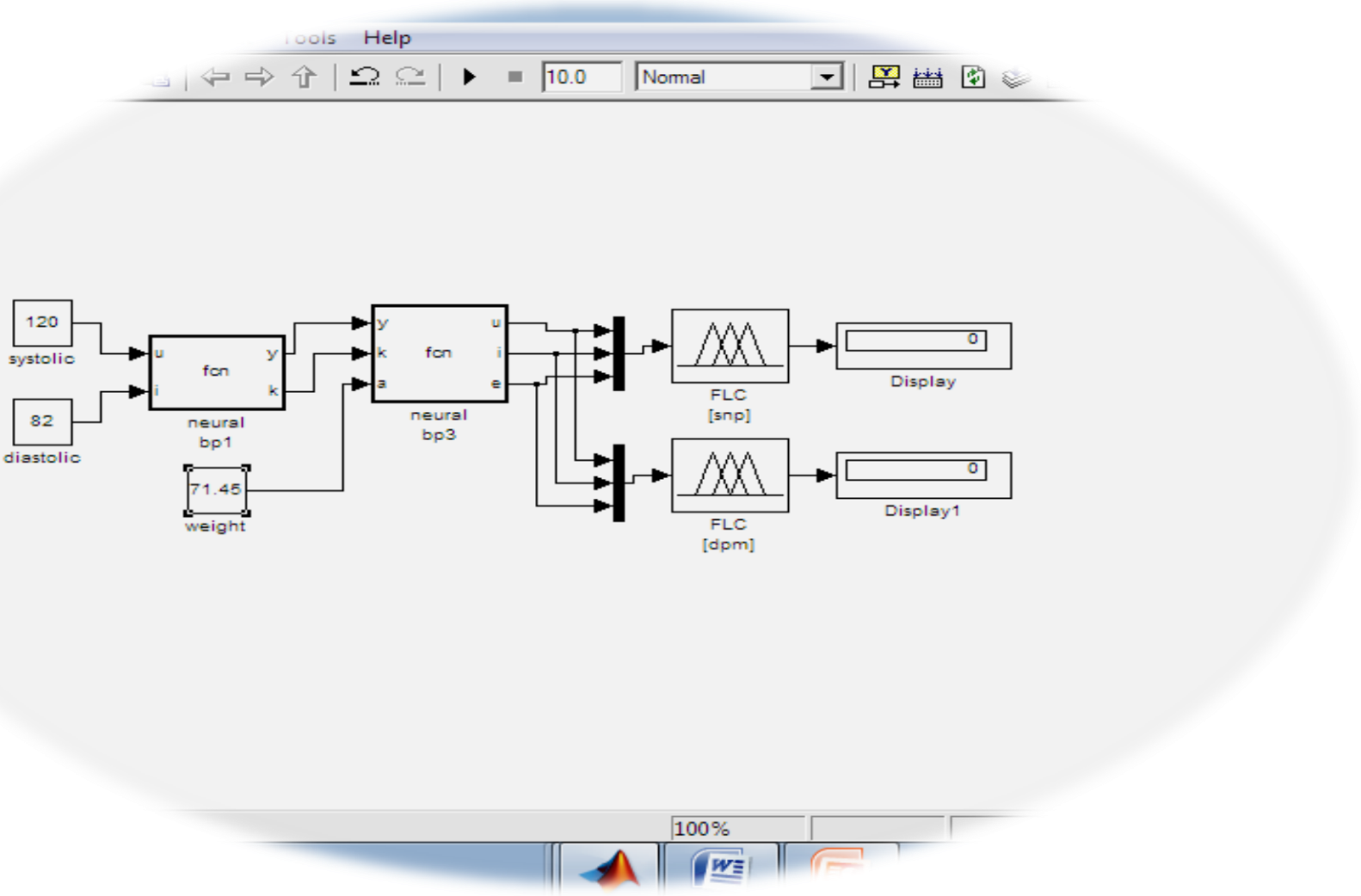
Simulation of fuzzy control system:



Fuzzy neural system:

- Finally the connection of two above systems was introduced fuzzy neural system, which work by both concepts of fuzzy and neural systems. Neural system was received inputs from measuring device, then the neural outputs was became inputs of fuzzy system, after that the outputs (results), was connected to infusion pump, that connected to the patient, to regulate the blood pressure.

Simulation of fuzzy neural system:



Samples of blood pressure fuzzy neural results:

weights	Very low	low	normal	high	Very high
45	12.05	7.997	0	4.5	7.002
55	14.02	9.99	0	5.505	7.996
60	16.01	10.51	0	5.985	9
75	19.47	13	0	7.515	11
80	20.96	13.99	0	7.995	12.01
95	24.95	17	0	9.511	14
115	30.03	21	0	11.51	17

Sample of compares between the results of both proposed systems:

weights	Very low (neural)	Very low (fuzzy neural)	Stander infusion drugs	Difference (Neural)	Difference (Fuzzy neural)
55	13,5579	14.02	14	-0.4421	+0.02
95	24.5579	24.95	25	-0.4421	-0.05
weights	Low (neural)	Low (fuzzy neural)	Stander infusion drugs	Difference (Neural)	Difference (Fuzzy neural)
55	10.0692	9.99	10	+0.0692	-0.01
95	17.0692	17	17	+0.0692	0

Cont…

weights	Normal (neural)	Normal (fuzzy neural)	Stander infusion drugs	Difference (Neural)	Difference (Fuzzy neural)
55	0.0270	0	0	+0.0270	0
95	0.0270	0	0	+0.0270	0
Weights	High (neural)	High (fuzzy neural)	Stander infusion drugs	Difference (Neural)	Difference (Fuzzy neural)
55	5.5734	5.505	5.5	+0.0734	+0.005
95	9.5734	9.511	9.5	+0.0734	+0.011

Cont…

Weights	Very high (neural)	Very high (fuzzy neural)	Stander infusion drugs	Difference (Neural)	Difference (Fuzzy neural)
55	7.7944	7.996	8	-0.2056	-0.004
95	13.7944	14	14	-0.2056	0

Conclusion:

- So all above compares was refers to a fuzzy neural system as acceptable system that can be used to regulate the blood pressure, than neural system.


THANK YOU