Topic :- fault diagnosis tool for distribution system with the help of artificial intelligence techniques

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- Classification of Artificial Intelligence
- The process of AI-based fault detection methods
- Different AI-Topologies (Fuzzy Logic, Artificial Neural Network and Adaptive Neuro Fuzzy Interference System)
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Introduction :

Due to certain failures in the power system faults arise which may make the entire system malfunctioning or failure. To enable seamless operation of the power system, these faults need to be detected and located accurately.

Fault should be detected as quickly as possible in real time so that appropriate remedial action can be taken before major disturbances to the Power supply can occur.

Correct diagnosis and early detection of incipient faults results in immediate unscheduled maintenance and short downtime for the system under consideration.

Objective :

- Aim is to detection of fault and also the type and location of the fault in distribution system using the help of artificial intelligence techniques.

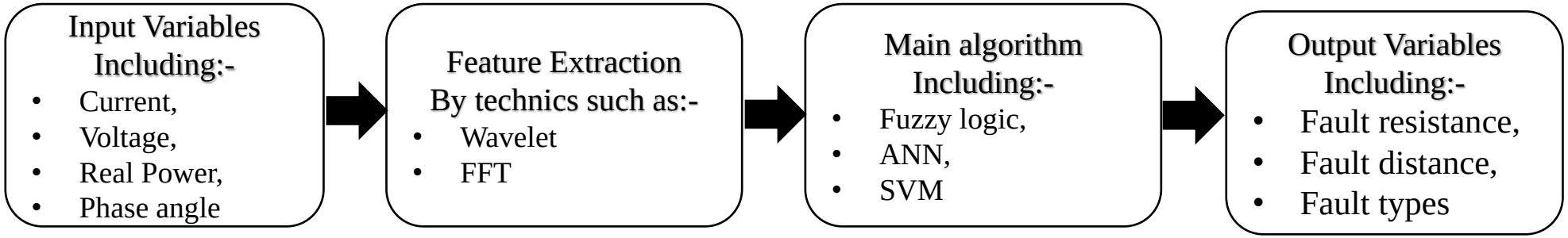
➢ What is Artificial Intelligence ?

- Artificial Intelligence (AI) refers to the simulation of human intelligence in machines or computer systems.
- Aims to create intelligent machines capable of performing tasks that typically require human intelligence.
- These tasks include learning from experience, reasoning, problem-solving, understanding natural language

➢ Application of AI in Distribution System :-

- Fault Detection and Diagnosis
- Predictive Maintenance
- Optimization and Load Balancing
- Power Quality Improvement
- Demand Response and Load Forecasting
- Integration of Renewable Energy
- Fault Localization and Isolation
- Efficient Energy Management

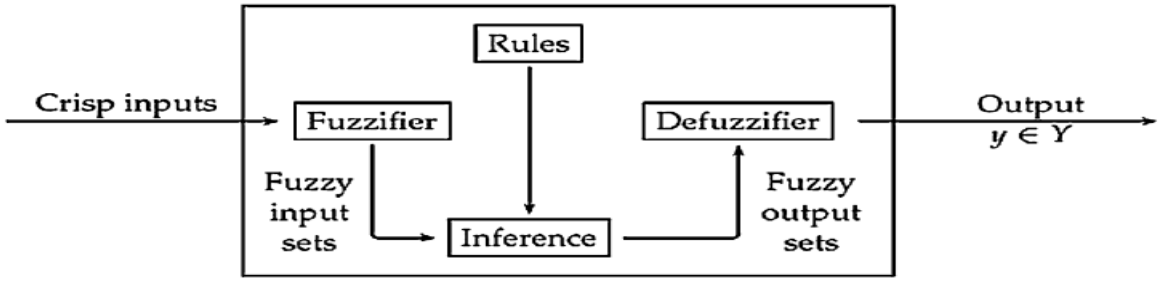
The process of AI-based fault detection methods



❑ Feature Extraction : -

- The process of Transforming raw data into numerical features
- Reduce data form Data set
- For better result

1. FUZZY LOGIC



1. **Fuzzification** : Crisp input values, and are transformed into fuzzy sets to be able to use them for computing
2. **Rules (domain expert)** : each Rule selects one output fuzzy member for given crisp input.

- logical reasoning and analytical skill of expert helps a lot in rule building.
- No mathematics required in deciding rules and Fuzzy logic reduces computation burden.

3. **Defuzzification :** The single fuzzy sets are converted back to crisp values

Fault diagnosis on electrical Distribution system using fuzzy logic

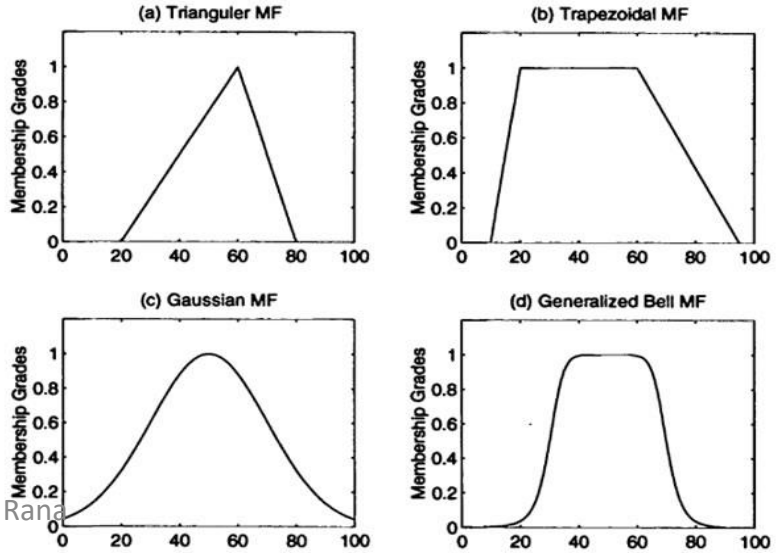
Crisp input → **Fuzzy input** → **Fuzzy output** → **Crisp output**

Input Variables Including:-	Membership function Including:-	Fuzzy Inference System	Membership function Including:-	Output Variables Including:-
• Current, • Voltage, • Real Power, • Phase angle	• Triangular, • Trapezoidal	• Mamdani type • Sugeno type	• Triangular, • Trapezoidal	• Fault resistance, • Fault distance, • Fault types

Fuzzification — **Rules (Domain expert)** — **Defuzzification**

Membership function :

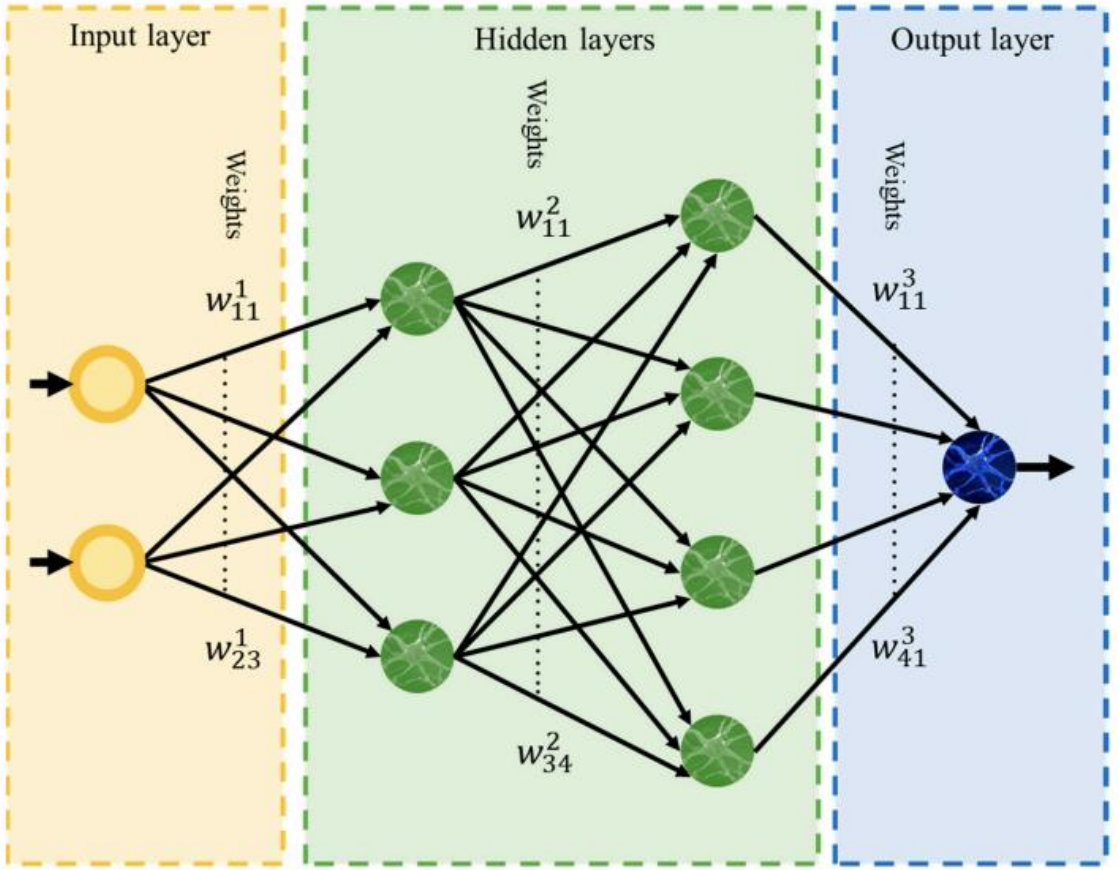
✓ Is curve that define how each point in the input space is mapped to a membership value (each point in a specified input partition) between 0 and 1.



2. ARTIFICIAL NEURAL NETWORK

➢ Input Layer:

- This layer accepts input features.
- It provides information from the outside world to the network, no computation is performed at this layer, nodes here just pass on the information to the hidden layer.



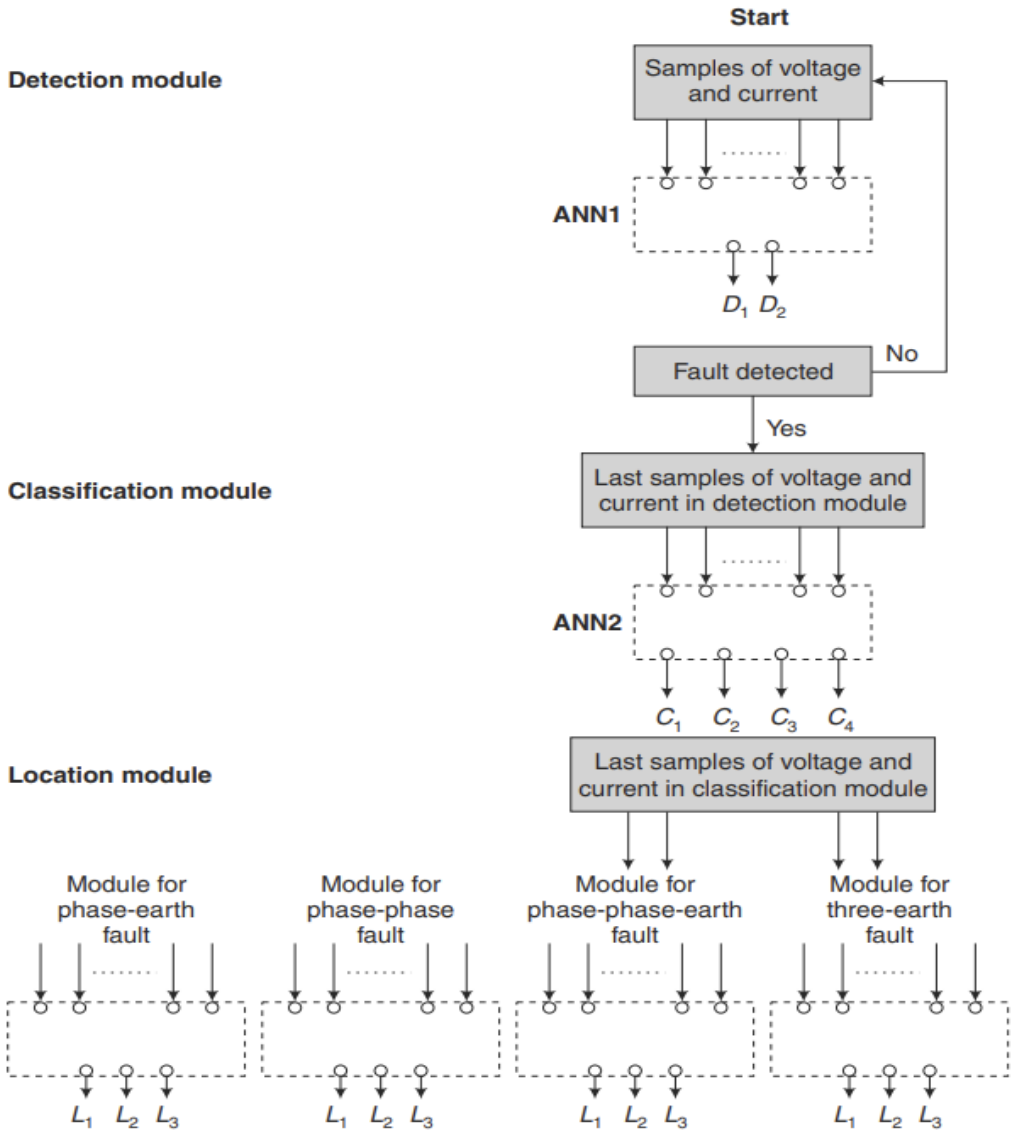
➢ Hidden Layer:

- Nodes of this layer are not exposed to the outer world,
- The hidden layer performs all sorts of computation on the features entered through the input layer and transfers the result to the output layer.

➢ Output Layer:

- This layer bring up the information learned by the network to the outer world.

ANN modular approach to fault Detection, Classification and Location

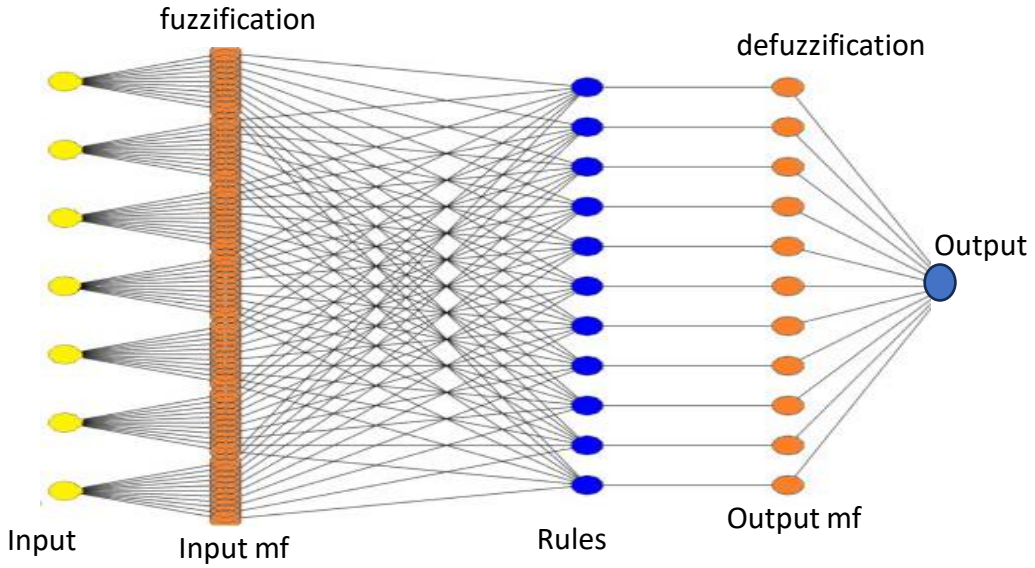


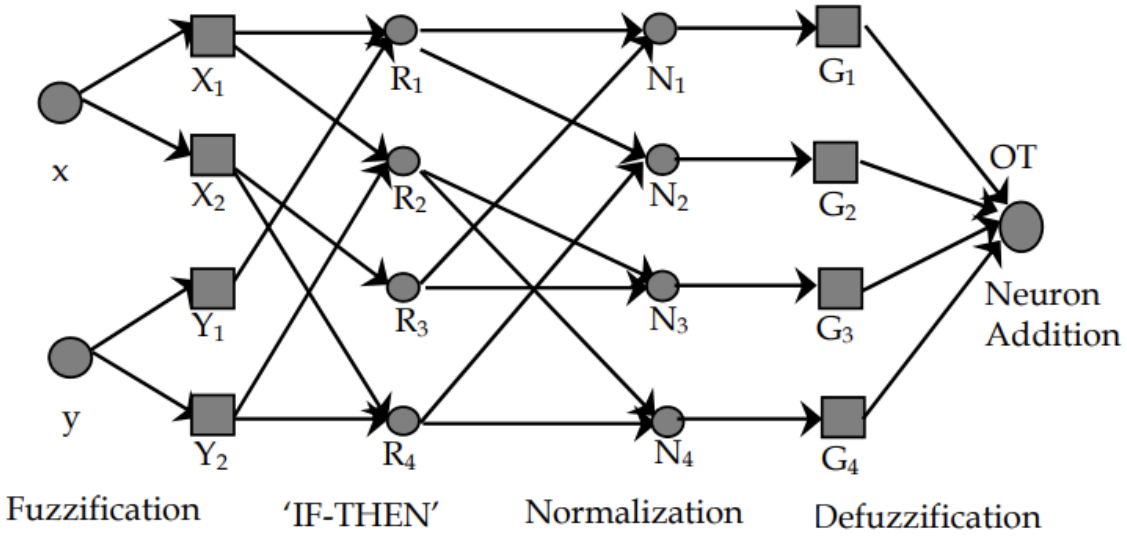
Detection module		
Situation	D_1	D_2
Normal	0	0
Reverse fault	1	0
Forward fault	0	1

Classification module				
Fault Situation	C_1	C_2	C_3	C_4
a-g	1	0	0	1
b-g	0	1	0	1
c-g	0	0	1	1
a-b	1	1	0	0
b-c	0	1	1	0
c-a	1	0	1	0
a-b-g	1	1	0	1
b-c-g	0	1	1	1
c-a-g	1	1	0	1
a-b-c	1	1	1	0
a-b-c-g	1	1	1	1

Location module			
Fault Situation	L_1	L_2	L_3
Zone 1	1	0	1
Zone 2	0	1	0
Zone 3	0	0	1

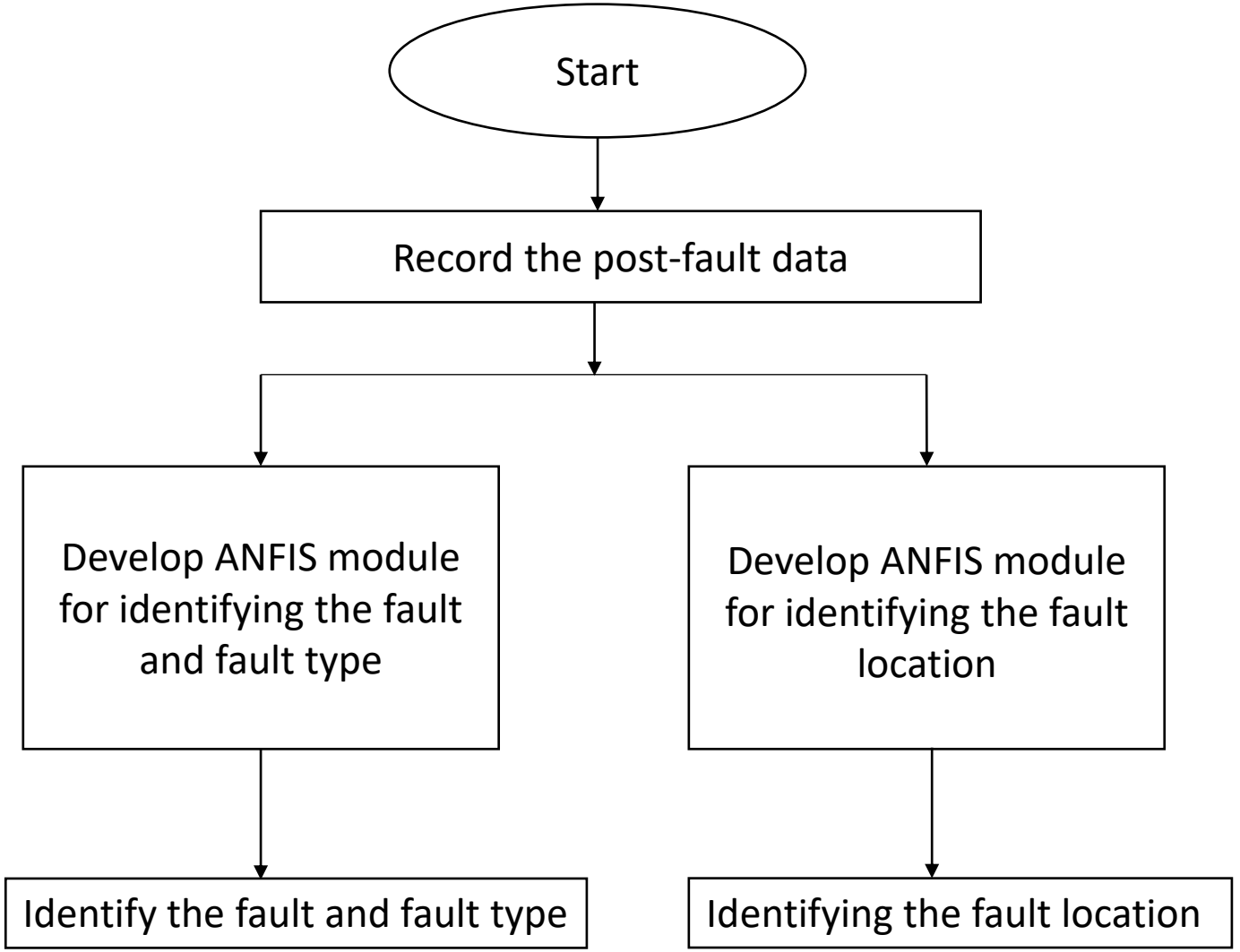
3. ADAPTIVE NEURO FUZZY INFERENCE SYSTEM





- An Adaptive neuro fuzzy inference system (ANFIS) is a type of artificial intelligence that combines the benefits of both neural networks and fuzzy logic systems.
- ANFIS is able to learn and make decisions based on data like a neural network
- handle imprecise or incomplete data, like a fuzzy logic system

ANFIS modular approach to fault Detection, Classification and Location



POWER SYSTEM PROBLEM

Generator

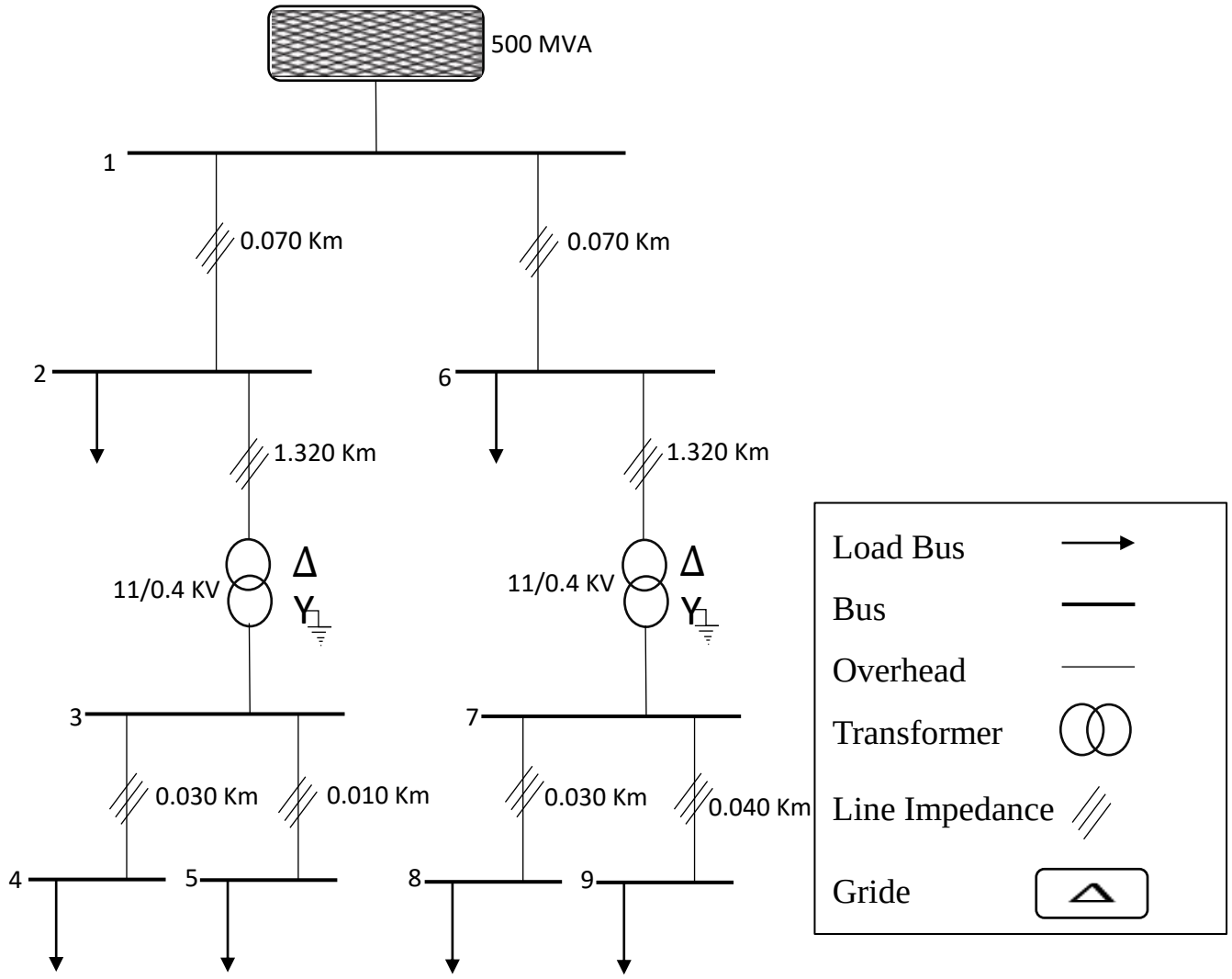
- **Rating = 500 MVA**
- **Voltage = 11KV**
- **Frequency = 50Hz**

Transformer

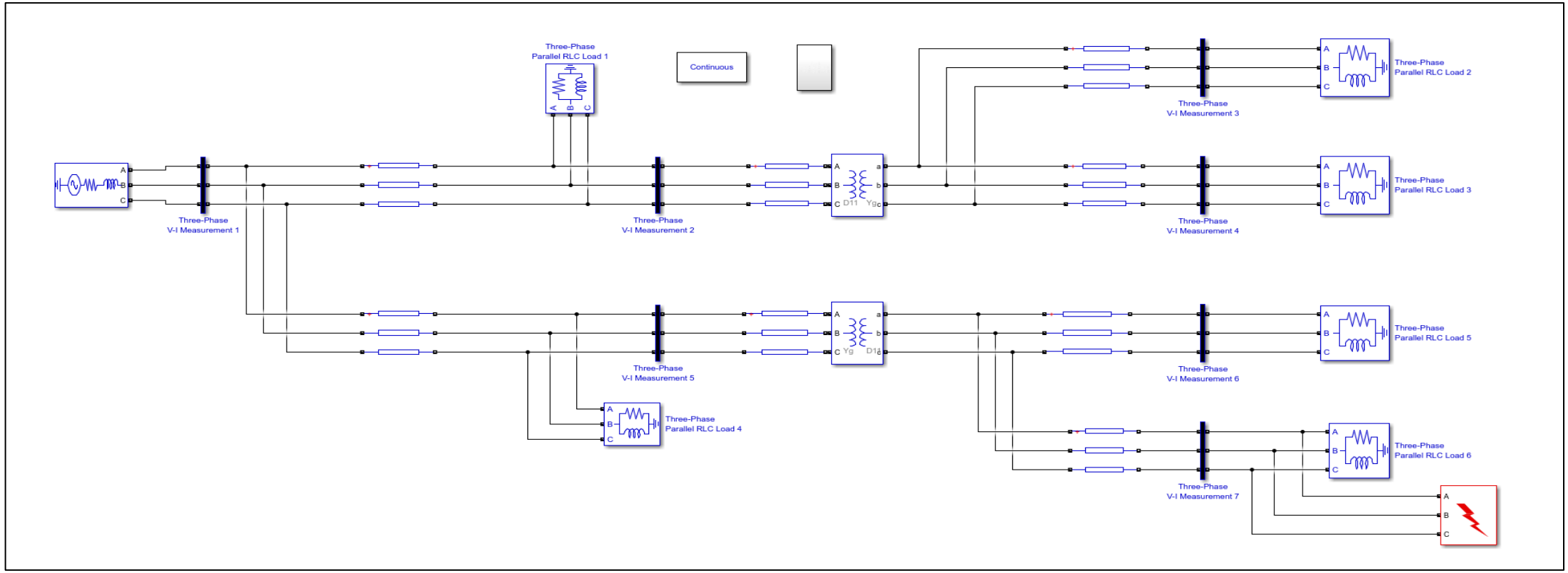
- **Rating = 2500 KVA**
- **Winding Type = Δ-Y**
- **Voltage Ratio = 11/0.4KV**
- **Frequency = 50Hz**

Load

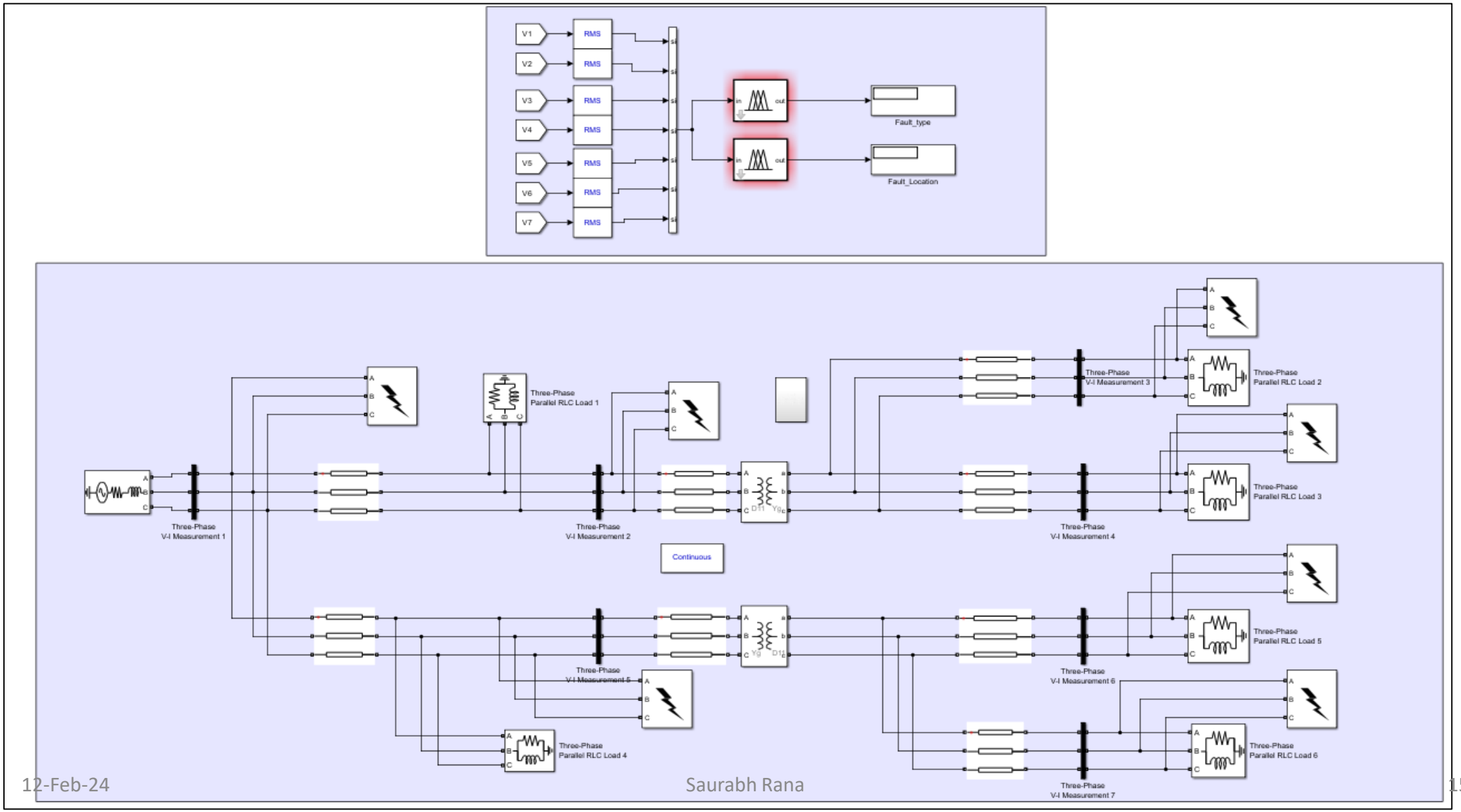
- **Active Power = 1764.9 KW**
- **Reactive Power = 1093.8 KVAR**
- **Voltage = 0.415 KV**
- **Frequency = 50 Hz**



MATLAB simulation of sample distribution system



1. Fuzzy Logic implemented in sample distribution system



Fuzzy Logic input and output Membership Range

Table 1. INPUT MEMBERSHIP FUNCTION RANGE

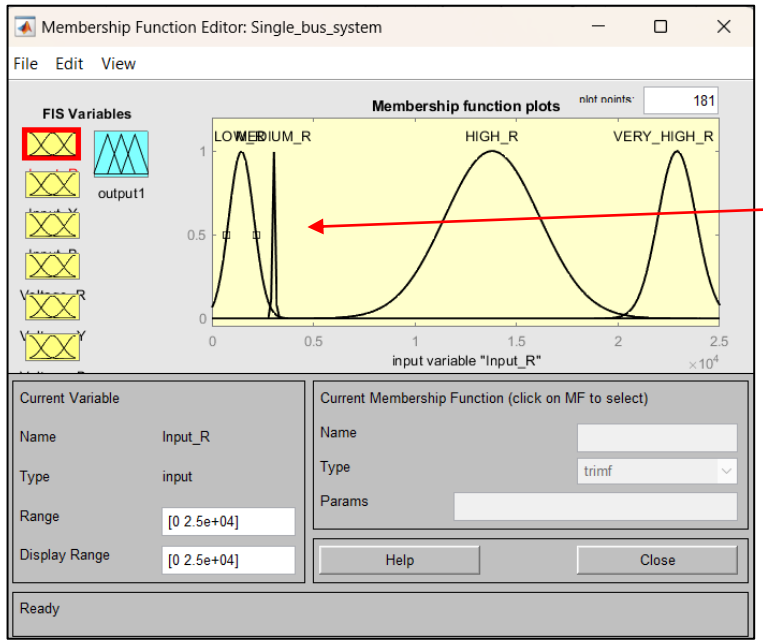
Input Membership Functions	Range
Very High	[6.1e^3 6.8e^3 7.5e^3]
High	[2.5e^3 3.0e^3 3.5e^3]
Medium	[150 225 300]
Low	[25 87.5 150]
Very Low	[0 12.5 25]

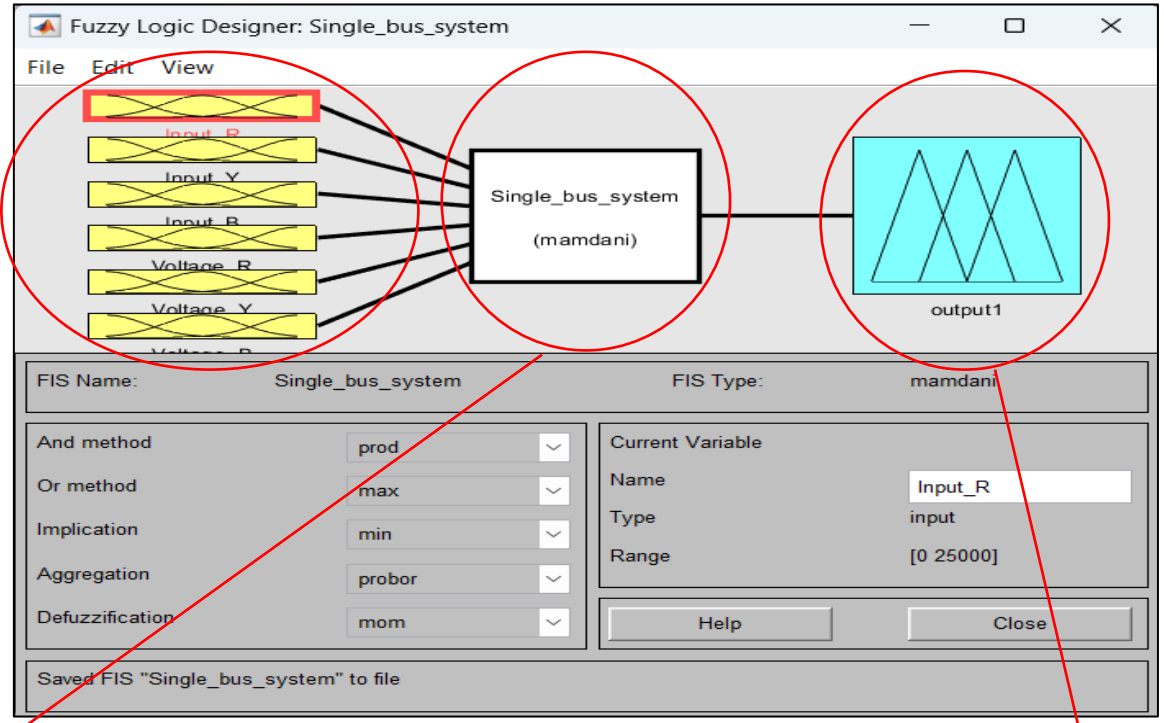
Fault Condition at different Location	Output Membership Functions Range
No-Fault	[0.0 0.0 0.0]
Bus-1	[0.5 1.0 1.5]
Bus-2	[1.5 2.0 2.5]
Bus-3	[2.5 3.0 3.5]
Bus-4	[3.5 4.0 4.5]
Bus-5	[4.5 5.0 5.5]
Bus-6	[5.5 6.0 6.5]
Bus-7	[6.5 7.0 7.5]

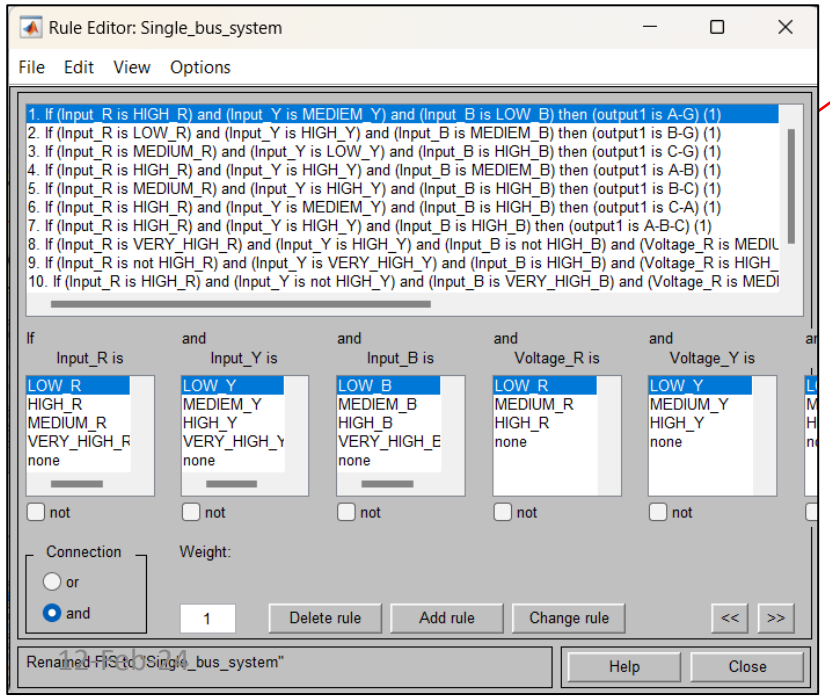
Table 2. FUZZY VARIABLE TO REPRESENT THE DIFFERENT FAULT TYPES ALONG WITH THEIR EQUIVALENT FUZZY FAULT CODE

	b1	b2	b3	b4	Equivalent decimal number	Triplets		
						A	B	C
No Fault	0	0	0	0	0	0	0	0
A-G	1	0	0	1	9	8.5	9	9.5
B-G	0	1	0	1	5	4.5	5	5.5
C-G	0	0	1	1	3	2.5	3	3.5
A-B	1	1	0	0	12	11.5	12	12.5
B-C	0	1	1	0	6	5.5	6	6.5
A-C	1	0	1	0	10	9.5	10	10.5
A-B-G	1	1	0	1	13	12.5	13	13.5
B-C-G	0	1	1	1	7	6.5	7	7.5
A-C-G	1	0	1	1	11	10.5	11	11.5
Symmetrical fault	1	1	1	1	14	13.5	14	14.5

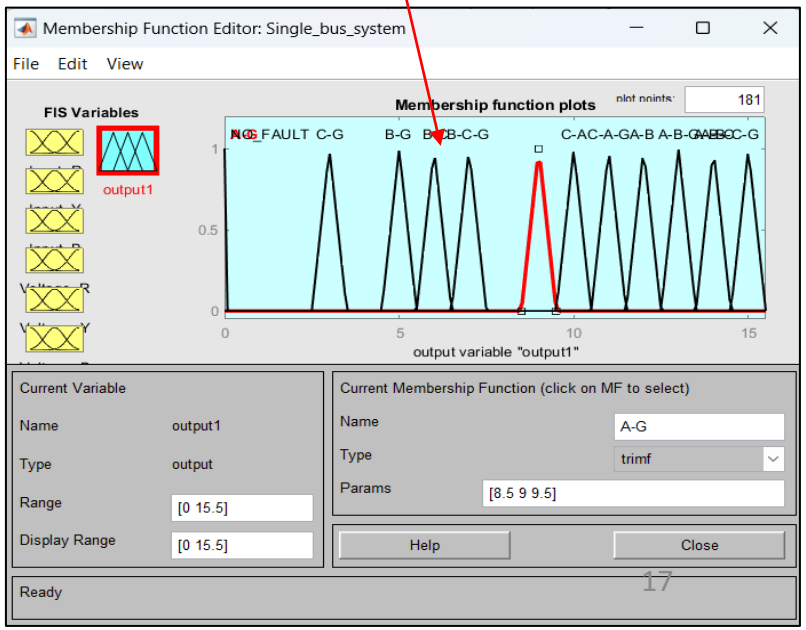
Table 3. FUZZY VARIABLE TO REPRESENT THE DIFFERENT FAULT LOCATION ALONG WITH THEIR EQUIVALENT FUZZY FAULT CODE



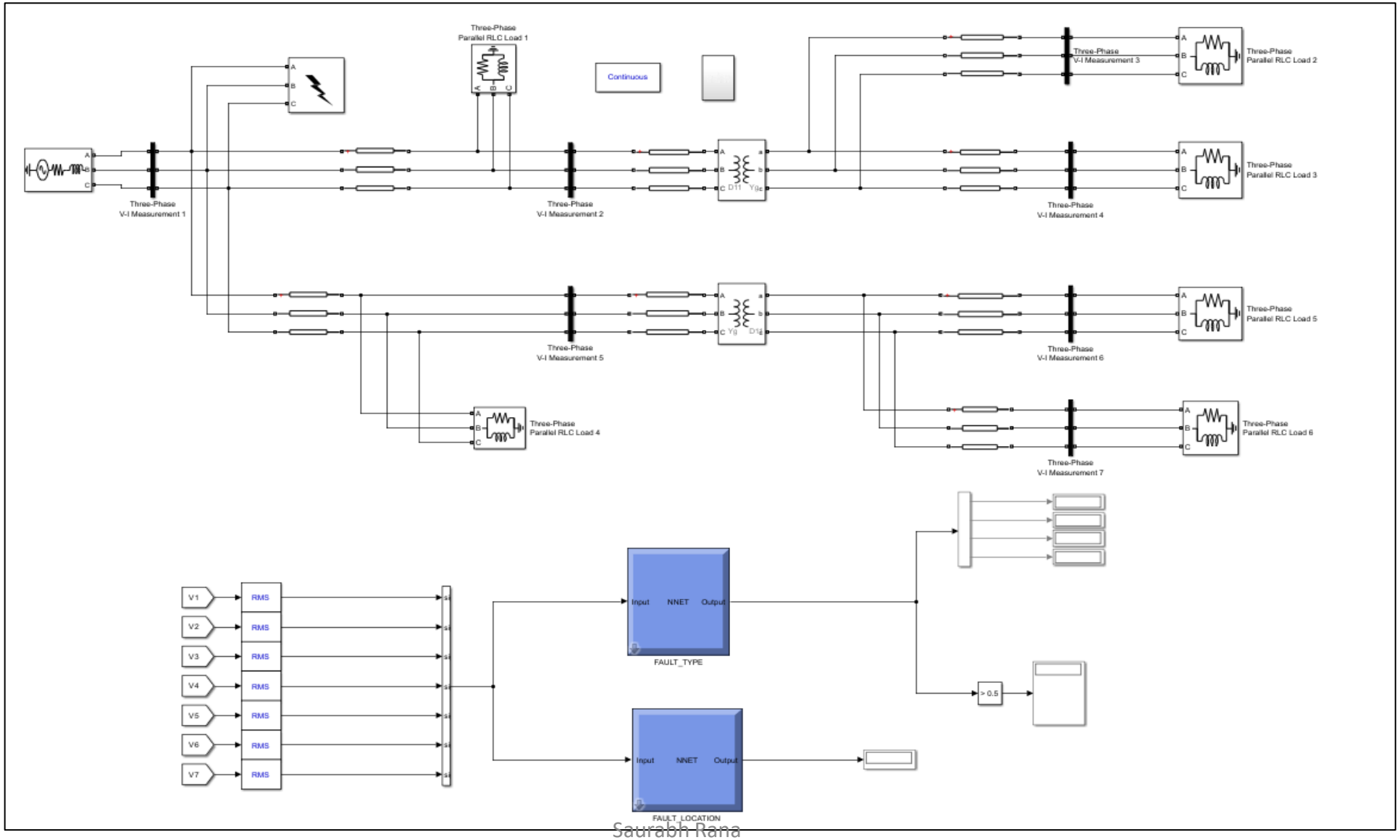




- [Fuzzy Logic tool-box :]



2. ANN implemented in sample distribution system



▪ Training data of ANN :-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	6.2794e+03	6.2783e+03	6.2782e+03	6.2857e+03	6.2831e+03	6.2848e+03	183.7580	183.7467	183.7437	196.9977	196.9878	196.9835	6.2849e+03	6.2855e+03	6.2855e+03	170.0338	170.0832	170.0689	164.4447	164.4928	164
2	284.4341	6.4062e+03	6.1869e+03	6.2863e+03	6.2808e+03	6.2866e+03	183.8257	183.7117	183.7216	197.0705	196.9538	196.9559	6.2854e+03	6.2832e+03	6.2873e+03	170.0107	170.0533	170.1317	164.4209	164.4652	164
3	6.1838e+03	285.0527	6.4091e+03	6.2832e+03	6.2849e+03	6.2855e+03	183.7351	183.7093	183.8253	196.9778	196.9437	197.0704	6.2824e+03	6.2873e+03	6.2862e+03	169.9897	170.1563	170.0597	164.4034	164.5640	164
4	6.4086e+03	6.1848e+03	280.6470	6.2849e+03	6.2824e+03	6.2863e+03	183.7819	183.6986	183.7549	197.0255	196.9367	196.9927	6.2840e+03	6.2848e+03	6.2870e+03	169.9911	170.0864	170.0963	164.4031	164.4970	164
5	3.1534e+03	3.1306e+03	6.2840e+03	6.2860e+03	6.2769e+03	6.2907e+03	183.9554	183.6065	183.6935	197.2123	196.8474	196.9167	6.2852e+03	6.2793e+03	6.2914e+03	169.9302	170.0049	170.2573	164.3403	164.4217	164
6	6.2774e+03	3.1498e+03	3.1275e+03	6.2837e+03	6.2827e+03	6.2871e+03	183.7976	183.6797	183.7894	197.0444	196.9158	197.0283	6.2829e+03	6.2851e+03	6.2878e+03	169.9723	170.1147	170.1159	164.3850	164.5249	164
7	3.1266e+03	6.2751e+03	3.1486e+03	6.2866e+03	6.2799e+03	6.2871e+03	183.8465	183.6975	183.6999	197.0925	196.9403	196.9314	6.2858e+03	6.2823e+03	6.2878e+03	170.0018	170.0301	170.1499	164.4117	164.4432	164
8	269.5130	268.8714	6.3129e+03	6.2857e+03	6.2830e+03	6.2850e+03	183.7713	183.7429	183.7586	197.0126	196.9836	196.9988	6.2848e+03	6.2854e+03	6.2857e+03	170.0303	170.0953	170.0829	164.4413	164.5048	164
9	6.3129e+03	272.2332	270.7995	6.2849e+03	6.2809e+03	6.2878e+03	183.8385	183.6662	183.7484	197.0871	196.9046	196.9823	6.2841e+03	6.2833e+03	6.2885e+03	169.9679	170.0720	170.1505	164.3796	164.4843	164
10	271.5587	6.3064e+03	271.8544	6.2864e+03	6.2766e+03	6.2907e+03	183.9539	183.6254	183.6729	197.2093	196.8684	196.8955	6.2855e+03	6.2790e+03	6.2914e+03	169.9493	169.9881	170.2521	164.3586	164.4051	164
11	14.2708	13.9377	13.9756	6.2846e+03	6.2833e+03	6.2857e+03	183.7731	183.7193	183.7819	197.0164	196.9576	197.0228	6.2838e+03	6.2857e+03	6.2864e+03	170.0068	170.1141	170.0891	164.4188	164.5234	164
12	6.2794e+03	6.2783e+03	6.2782e+03	6.2857e+03	6.2831e+03	6.2848e+03	183.7580	183.7467	183.7437	196.9977	196.9878	196.9835	6.2849e+03	6.2855e+03	6.2855e+03	170.0338	170.0832	170.0689	164.4447	164.4928	164
13	6.2785e+03	6.2783e+03	6.2791e+03	53.9567	6.7677e+03	6.7539e+03	183.7646	183.7124	183.7647	197.0069	196.9505	197.0044	6.2840e+03	6.2854e+03	6.2864e+03	170.0011	170.0984	170.0803	164.4132	164.5082	164
14	6.2786e+03	6.2733e+03	6.2839e+03	6.7512e+03	53.8974	6.7749e+03	183.9258	183.6045	183.7175	197.1817	196.8431	196.9434	6.2841e+03	6.2805e+03	6.2912e+03	169.9231	170.0294	170.2328	164.3343	164.4451	164
15	6.2782e+03	6.2719e+03	6.2857e+03	6.7716e+03	6.7454e+03	54.0179	183.9861	183.5555	183.7127	197.2480	196.7932	196.9341	6.2837e+03	6.2791e+03	6.2931e+03	169.8849	170.0145	170.2921	164.2961	164.4322	164
16	6.2784e+03	6.2719e+03	6.2856e+03	3.1461e+03	3.1461e+03	6.2922e+03	183.9690	183.5553	183.7062	197.2294	196.7927	196.9278	6.2839e+03	6.2790e+03	6.2929e+03	169.8837	170.0101	170.2758	164.2951	164.4278	164
17	6.2798e+03	6.2778e+03	6.2782e+03	6.2862e+03	3.1431e+03	3.1431e+03	183.7730	183.7498	183.7279	197.0130	196.9923	196.9661	6.2854e+03	6.2849e+03	6.2855e+03	170.0396	170.0677	170.0807	164.4499	164.4779	164
18	6.2786e+03	6.2717e+03	6.2857e+03	3.1382e+03	6.2764e+03	3.1382e+03	183.9831	183.5544	183.7013	197.2443	196.7924	196.9219	6.2840e+03	6.2788e+03	6.2930e+03	169.8847	170.0042	170.2882	164.2958	164.4223	164
19	6.2784e+03	6.2754e+03	6.2820e+03	46.0383	46.0506	7.0471e+03	183.8576	183.6445	183.7407	197.1080	196.8824	196.9725	6.2840e+03	6.2826e+03	6.2893e+03	169.9507	170.0610	170.1691	164.3624	164.4742	164
20	6.2784e+03	6.2784e+03	6.2791e+03	7.0427e+03	46.0076	46.0269	183.7637	183.7160	183.7652	197.0057	196.9543	197.0051	6.2840e+03	6.2855e+03	6.2864e+03	170.0043	170.0993	170.0791	164.4163	164.5090	164
21	6.2788e+03	6.2727e+03	6.2845e+03	45.9681	7.0345e+03	45.9567	183.9430	183.5911	183.7150	197.2005	196.8296	196.9396	6.2843e+03	6.2798e+03	6.2918e+03	169.9129	170.0241	170.2495	164.3240	164.4405	164
22	6.2779e+03	6.2785e+03	6.2796e+03	3.0099	3.0094	3.0108	183.7672	183.6971	183.7810	197.0109	196.9336	197.0212	6.2834e+03	6.2856e+03	6.2869e+03	169.9859	170.1115	170.0857	164.3986	164.5212	164
23	6.2794e+03	6.2783e+03	6.2782e+03	6.2857e+03	6.2831e+03	6.2848e+03	183.7580	183.7467	183.7437	196.9977	196.9878	196.9835	6.2849e+03	6.2855e+03	6.2855e+03	170.0338	170.0832	170.0689	164.4447	164.4928	164
24	6.2791e+03	6.2764e+03	6.2805e+03	6.2854e+03	6.2811e+03	6.2871e+03	21.3914	184.4310	183.6660	197.0824	196.9342	196.9643	6.2846e+03	6.2835e+03	6.2878e+03	169.9941	170.0586	170.1436	164.4048	164.4708	164
25	6.2794e+03	6.2746e+03	6.2820e+03	6.2857e+03	6.2793e+03	6.2886e+03	183.8090	21.5734	184.4470	197.1245	196.8914	196.9394	6.2849e+03	6.2817e+03	6.2893e+03	169.9613	170.0322	170.1807	164.3720	164.4464	164
26	6.2785e+03	6.2784e+03	6.2791e+03	6.2848e+03	6.2831e+03	6.2857e+03	184.5010	183.6507	21.3033	197.0054	196.9542	197.0020	6.2840e+03	6.2855e+03	6.2864e+03	170.0043	170.0966	170.0786	164.4163	164.5064	164
27	6.2778e+03	6.2727e+03	6.2855e+03	6.2841e+03	6.2774e+03	6.2921e+03	92.3697	91.3673	183.7292	197.2132	196.7823	196.9527	6.2832e+03	6.2798e+03	6.2928e+03	169.8723	170.0318	170.2639	164.2847	164.4488	164

Target data of ANN :-

Target data for fault type :-

Fault Condition	Target Data			
	C1	C2	C3	C4
No-Fault	0	0	0	0
A-G	1	0	0	1
B-G	0	1	0	1
C-G	0	0	1	1
A-B	1	1	0	0
B-C	0	1	1	0
A-C	1	0	1	0
A-B-G	1	1	0	1
B-C-G	0	1	1	1
A-C-G	1	0	1	1
Symmetrical fault	1	1	1	1

Target data for fault location :-

Fault Condition at different Location	Target Data
No-Fault	0
Bus-1	1
Bus-2	2
Bus-3	3
Bus-4	4
Bus-5	5
Bus-6	6
Bus-7	7

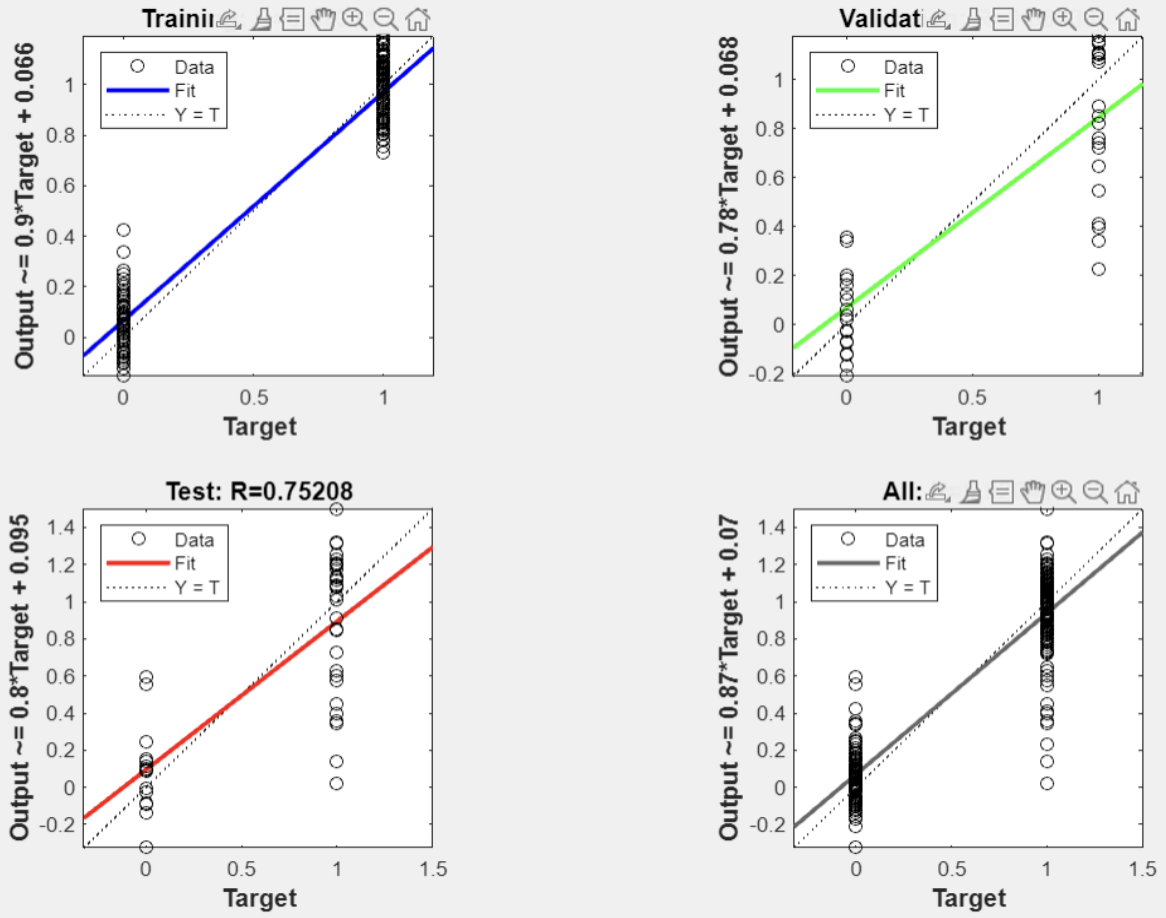
○ ANN algorithm for fault diagnosis

NEURAL NETWORK FITTING

Import | Training data: 70 % | Validation data: 15 | Test data: 15 | Layer size: 10 | Train | Stop | Training State | Performance | Error Histogram | Regression | Fit | Test | Test Plots | Export Plot to Figure | Generate Code | Export Model

DATA | SPLIT | BUILD | TRAIN | PLOTS | TEST | EXPORT

Network | Training | Regression Plot



Model Summary

Train a neural network to map predictors to continuous responses.

Data

Predictors: xdata - [78x21 double]

Responses: tdata - [78x4 double]

xdata: double array of 78 observations with 21 features.

tdata: double array of 78 observations with 4 features.

Algorithm

Data division: Random

Training algorithm: Levenberg-Marquardt

Performance: Mean squared error

Training Results

Training start time: 14-Oct-2023 14:08:08

Layer size: 10

	Observations	MSE	R
Training	54	0.0139	0.9733
Validation	12	0.0661	0.8604
Test	12	0.1194	0.7521

Additional Test Results

Predictors: xdata - [21x78 double]

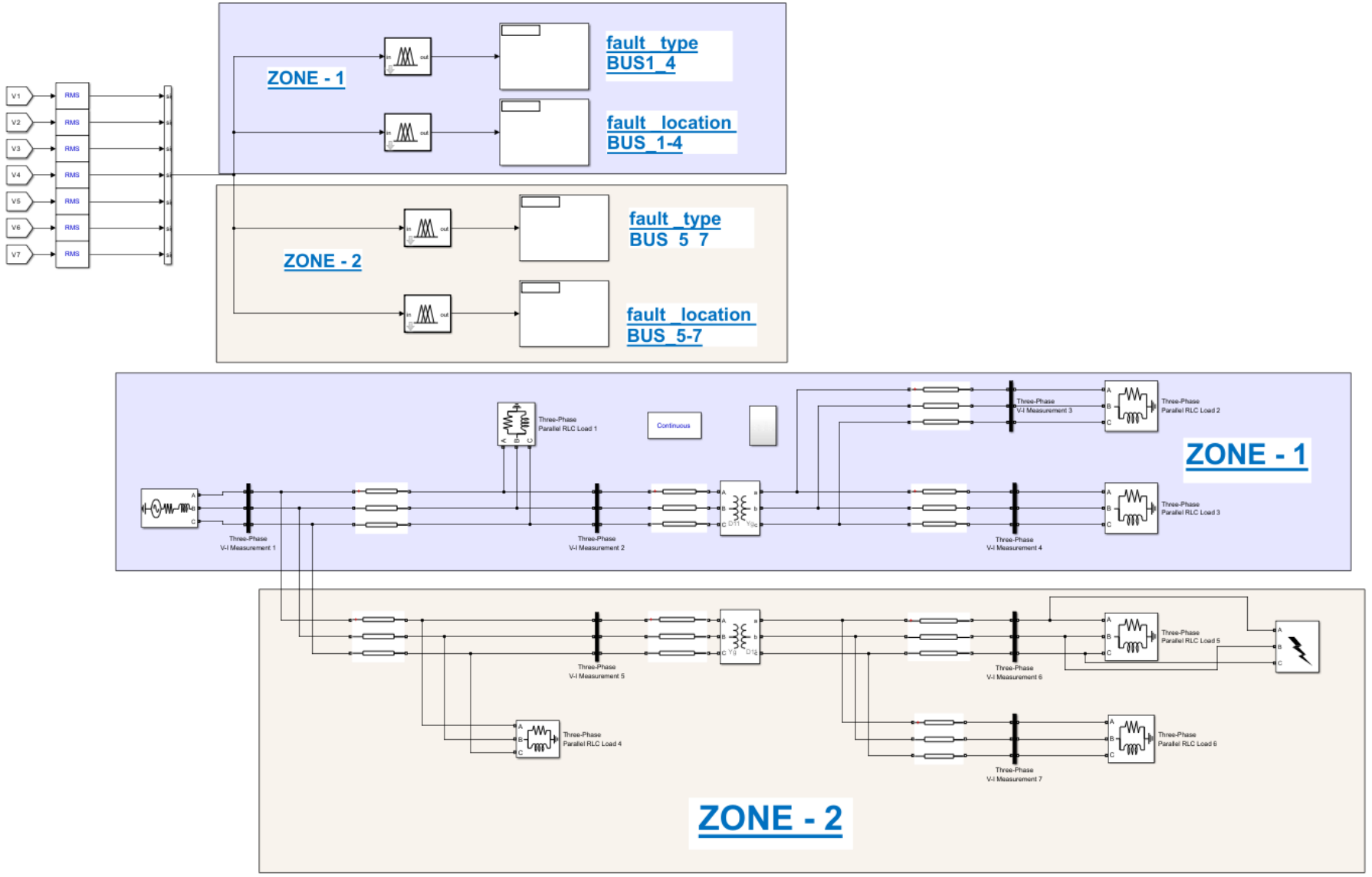
Responses: tdata - [4x78 double]

xdata: double array of 78 observations with 21 features.

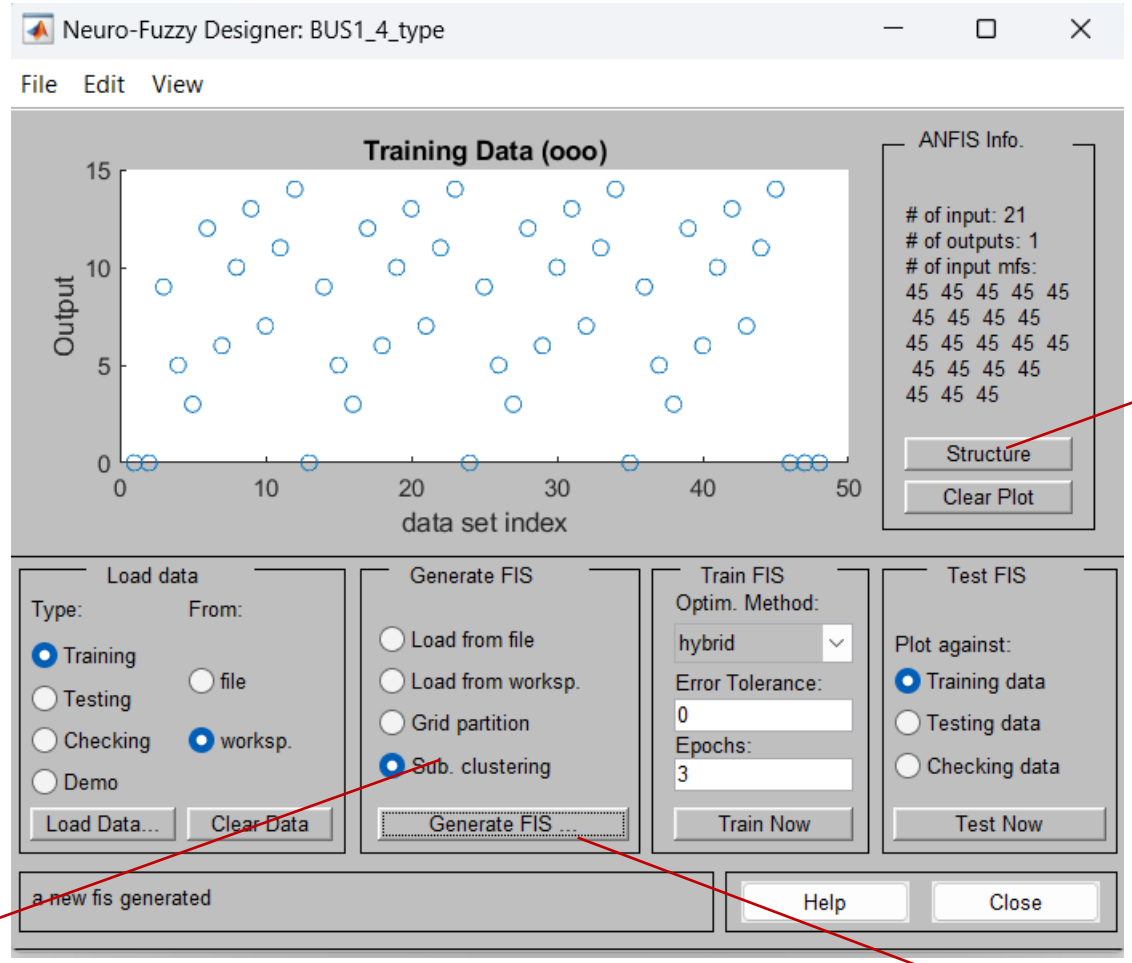
tdata: double array of 78 observations with 4 features.

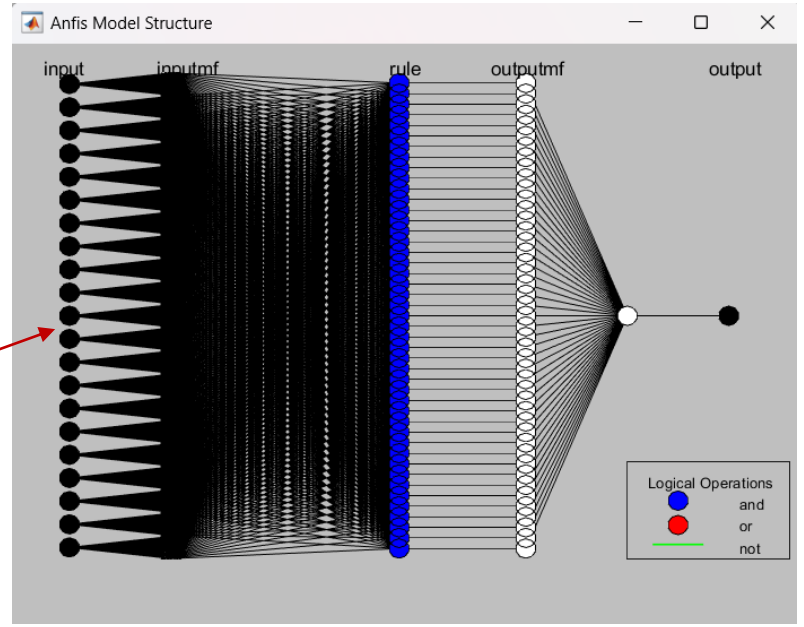
	Observations	MSE	R
Additional test	78	0.0381	0.9204

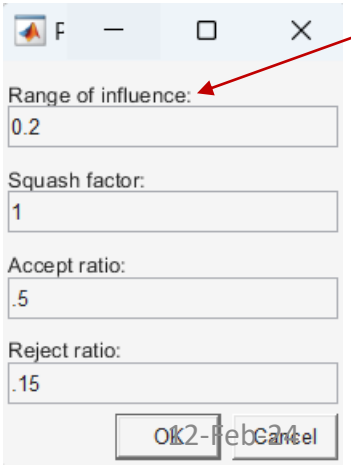
3. ANFIS implemented in sample distribution system

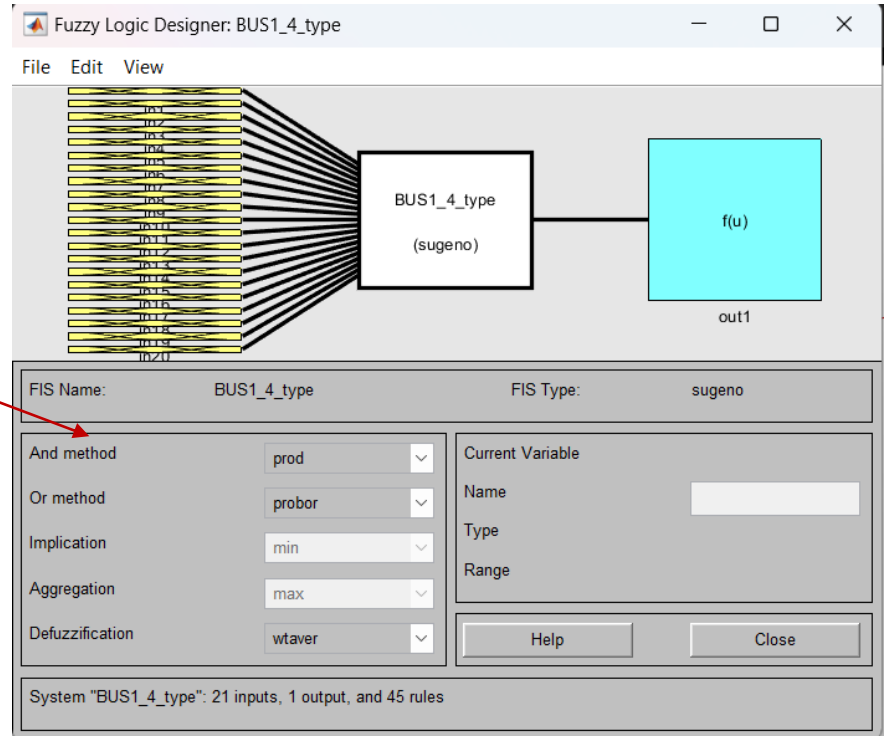


- ANFIS tool-box









ANFIS algorithm for fault diagnosis

Saurabh Rana

RESULTS AND DISCUSSION

1. FUZZY LOGIC RESULTS

- Fault Identification for Bus- 5&7 using Fuzzy Logic- Algorithm

Bus No.	Types of Faults										
	No-fault	A-G	B-G	C-G	A-B	B-C	C-A	A-B-G	B-C-G	A-C-G	Symmetrical Fault
Bus No. 5	0.00	8.99	4.96	2.945	12.01	6.045	9.998	13.02	6.975	11.01	13.95
Bus No. 7	0.00	8.99	4.96	2.945	12.01	6.045	9.998	13.02	6.975	11.01	14.03

- Fault Location for Bus- 5&7 using Fuzzy Logic- Algorithm

Bus No.	Types of Faults										
	No-fault	A-G	B-G	C-G	A-B	B-C	C-A	A-B-G	B-C-G	A-C-G	Symmetrical Fault
Bus No. 5	0.00	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96
Bus No. 7	0.00	6.975	6.975	6.975	6.975	6.975	6.975	6.975	6.975	6.975	7.052

2. ANN RESULTS

- Fault Identification for Bus- 5 using ANN- Algorithm

No.	Fault- Type	C1	C2	C3	C4	Fault – detected and Identification
1	No Fault	0.20	0.19	0.13	-0.03	✓
2	A-G	1.06	0.06	0.04	1.08	✓
3	B-G	0.27	1.02	0.05	0.85	✓
4	C-G	-0.07	-0.03	1.18	0.74	✓
5	A-B	0.79	0.90	0.05	0.16	✓
6	B-C	0.09	0.90	0.90	0.14	✓
7	A-C	0.83	0.06	0.94	0.34	✓
8	A-B-G	1.10	1.16	0.06	0.41	
9	B-C-G	0.01	1.18	1.11	0.87	✓
10	A-C-G	1.11	0.06	1.11	0.81	✓
11	Symmetrical Fault	0.82	1.16	1.11	0.04	✓

- Fault Identification for Bus- 7 using ANN- Algorithm

No.	Fault- Type	C1	C2	C3	C4	Fault – detected and Identification
1	No Fault	0.20	0.19	0.13	0.03	✓
2	A-G	1.03	0.07	0.10	1.07	✓
3	B-G	0.18	1.00	0.05	0.93	✓
4	C-G	-0.07	-0.11	1.15	0.85	✓
5	A-B	0.78	0.88	0.12	0.06	✓
6	B-C	0.15	0.82	0.90	-0.01	✓
7	A-C	0.86	0.06	0.90	0.06	✓
8	A-B-G	1.09	1.11	0.03	0.97	✓
9	B-C-G	-0.12	1.08	1.05	0.99	✓
10	A-C-G	1.19	-0.01	1.04	0.82	✓
11	Symmetrical Fault	0.99	0.99	1.01	0.09	✓

- Fault Location for Bus- 5&7 using ANN - Algorithm

Bus No.	Types of Faults										
	No-fault	A-G	B-G	C-G	A-B	B-C	C-A	A-B-G	B-C-G	A-C-G	Symmetrical Fault
Bus No. 5	0.26	5.01	4.98	4.91	5.073	5.044	3.65	5.041	4.941	4.667	5.10
Bus No. 7	0.26	7.03	6.85	6.62	7.019	6.78	6.939	7.569	6.957	6.82	6.94

3. ANFIS RESULTS

- Fault Identification for Bus- 5&7 using Fuzzy Logic- Algorithm

Bus No.	Types of Faults										
	No-fault	A-G	B-G	C-G	A-B	B-C	C-A	A-B-G	B-C-G	A-C-G	Symmetrical Fault
Bus No. 5	0.28	9.26	5.38	3.01	12.14	5.99	9.96	13.05	6.63	10.80	14.09
Bus No. 7	0.00	8.85	4.96	2.86	12.31	5.81	9.95	12.99	6.89	10.98	14.50

- Fault Location for Bus- 5&7 using Fuzzy Logic- Algorithm

Bus No.	Types of Faults										
	No-fault	A-G	B-G	C-G	A-B	B-C	C-A	A-B-G	B-C-G	A-C-G	Symmetrical Fault
Bus No. 5	- 0.05	4.93	5.13	5.10	5.11	5.17	5.11	4.92	5.08	5.00	5.08
Bus No. 7	- 0.01	7.02	7.02	7.04	7.04	7.05	7.07	7.00	7.00	7.00	7.06

COMPARISON OF DIFFERENT – AI TECHNIQUES RESULTS (BUS-5)

❑ MATLAB Result :– FAULT-TYPE

❑ MATLAB Result :– FAULT-LOCATION

NO.	Fault - Type	Equalent Decimal no.	FUZZY	ANN	ANFIS		FUZZY	ANN	ANFIS
1	No Fault	0	0	✓	0.28		0	0.2664	-0.05
2	A-G	9	8.99	✓	9.26		4.96	5.01	4.93
3	B-G	5	4.96	✓	5.38		4.96	4.98	5.13
4	C-G	3	2.945	✓	3.01		4.96	4.91	5.10
5	A-B	12	12.01	✓	12.14		4.96	5.073	5.11
6	B-C	6	6.045	✓	5.99		4.96	5.044	5.17
7	A-C	10	9.998	✓	9.96		4.96	3.65	5.11
8	A-B-G	13	13.02	✓	13.05		4.96	5.041	4.92
9	B-C-G	7	6.975	✓	6.63		4.96	4.941	5.08
10	A-C-G	11	11.01	✓	10.80		4.96	4.667	5.00
11	A-B-C	14	13.95	✓	14.09		4.96	5.10	5.08

COMPARISON OF DIFFERENT – AI TECHNIQUES RESULTS (BUS-7)

❑ MATLAB Result :– FAULT-TYPE

❑ MATLAB Result :– FAULT-LOCATION

NO.	Fault - Type	Equalent Decimal no.	FUZZY	ANN	ANFIS		FUZZY	ANN	ANFIS
1	No Fault	0	0	✓	0.00		0	0.2664	- 0.01
2	A-G	9	8.99	✓	8.85		6.975	7.03	7.02
3	B-G	5	4.96	✓	4.96		6.975	6.85	7.02
4	C-G	3	2.945	✓	2.86		6.975	6.617	7.04
5	A-B	12	12.01	✓	12.31		6.975	7.019	7.04
6	B-C	6	6.045	✓	5.81		6.975	6.779	7.05
7	A-C	10	9.998	✓	9.95		6.975	6.939	7.07
8	A-B-G	13	13.02		12.99		6.975	7.569	7.00
9	B-C-G	7	6.975	✓	6.89		6.975	6.957	7.00
10	A-C-G	11	11.01	✓	10.98		6.975	6.82	7.00
11	A-B-C	14	14.03	✓	14.5		7.052	6.94	7.06

CONCLUSION

The paper proposes a fault detection, identification, and location scheme for distribution systems that has high accuracy and is validated through MATLAB/Simulink simulations. Various AI techniques (fuzzy, ANN, and ANFIS) are utilized to diagnose faults in a sample distribution system. These techniques effectively detect, locate, and identify 10 types of faults using only the magnitudes of phase voltage or current measurements. While all AI techniques successfully detect and identify various faults, the ANN method falls short in detecting some specific faults for a given distribution system.

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Thank You!