1 Results

1.1 Main Results

1.2 Backward Feature Selection

1.3 Forward Feature Selection

1.4 Weight Analysis

1.5 Jackknife Sensitivity Analysis

1.6 Predictions Plots

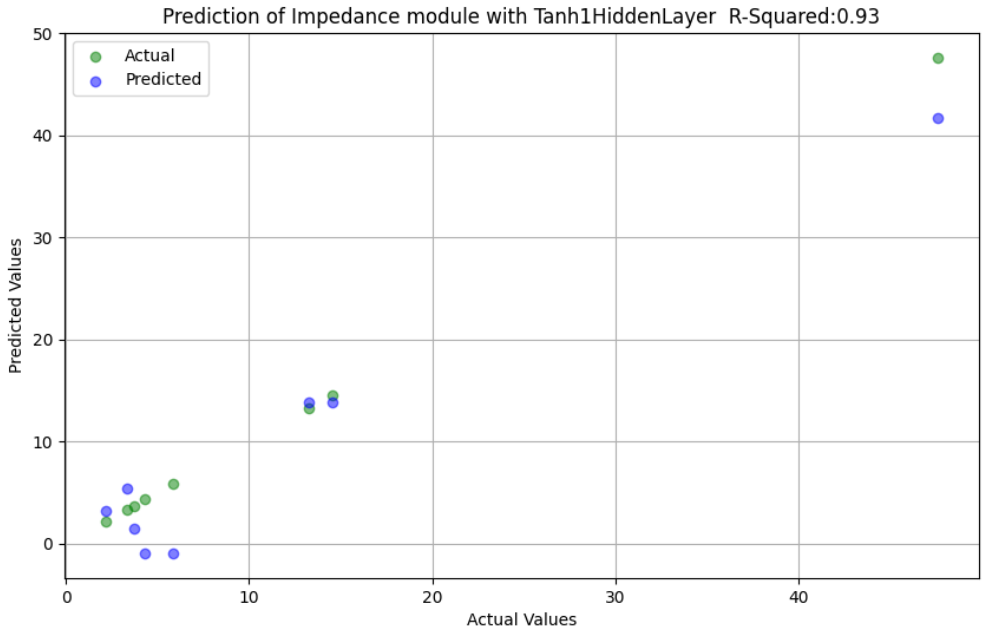

Figure 1: Prediction of Impedance module with Tanh1HiddenLayer - R-Squared: 0.93

1.7 Performance Plots

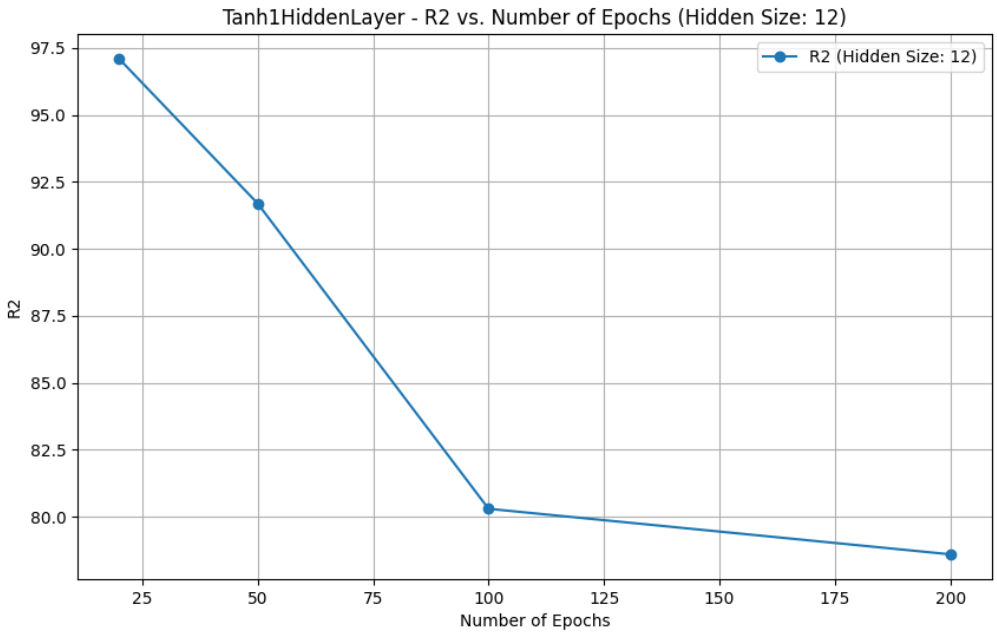

Figure 2: Tanh1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 12)

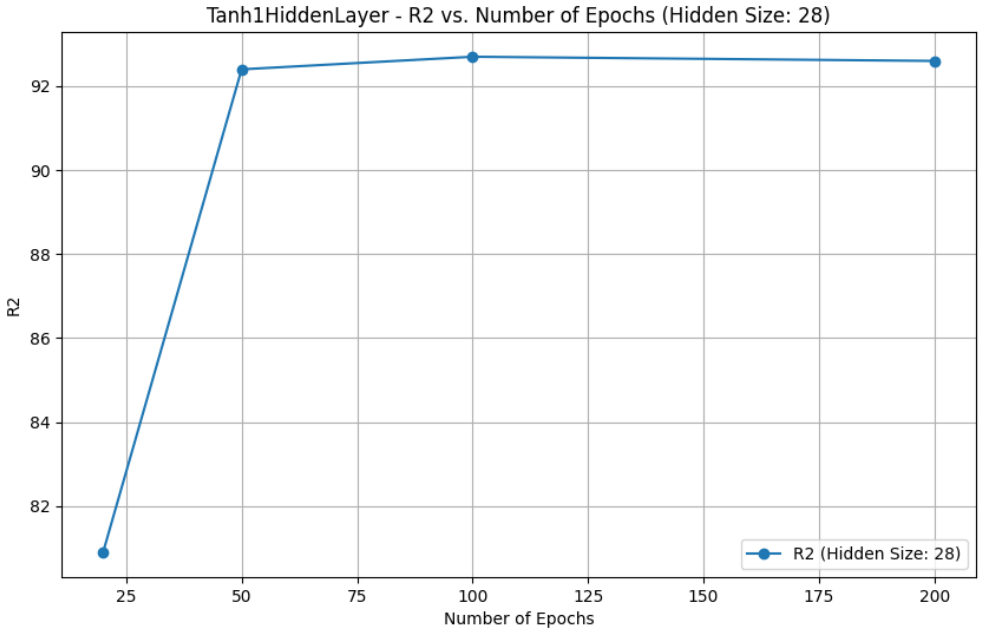

Figure 3: Tanh1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 28)

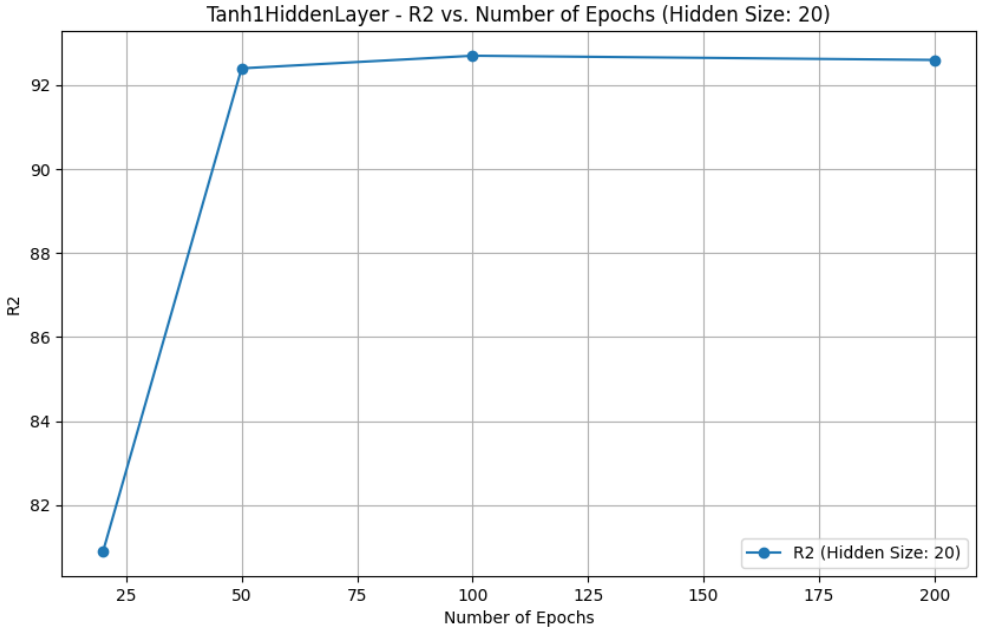

Figure 4: Tanh1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 20)

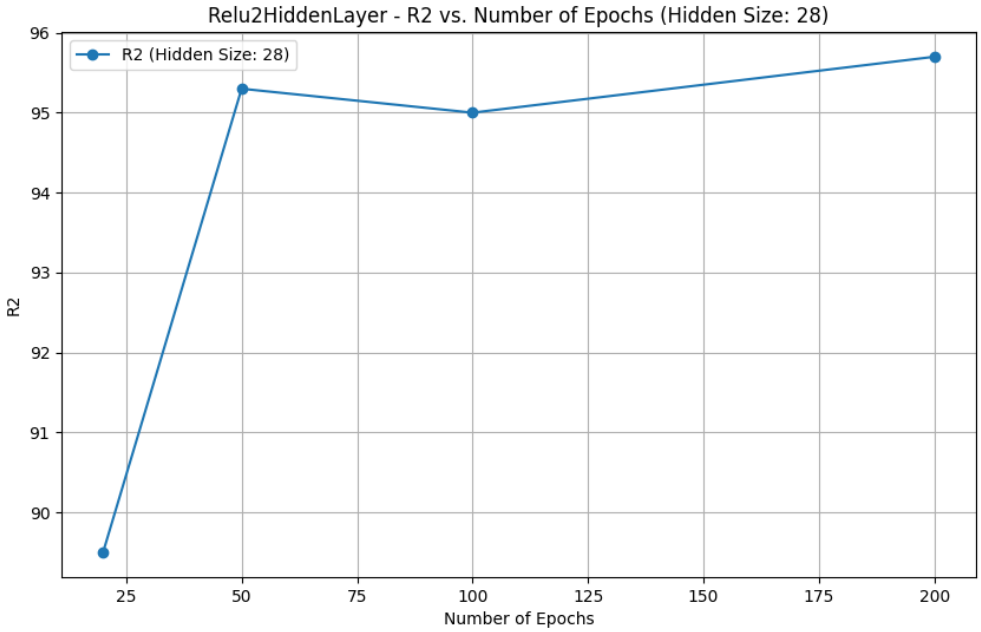

Figure 5: Relu2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 28)

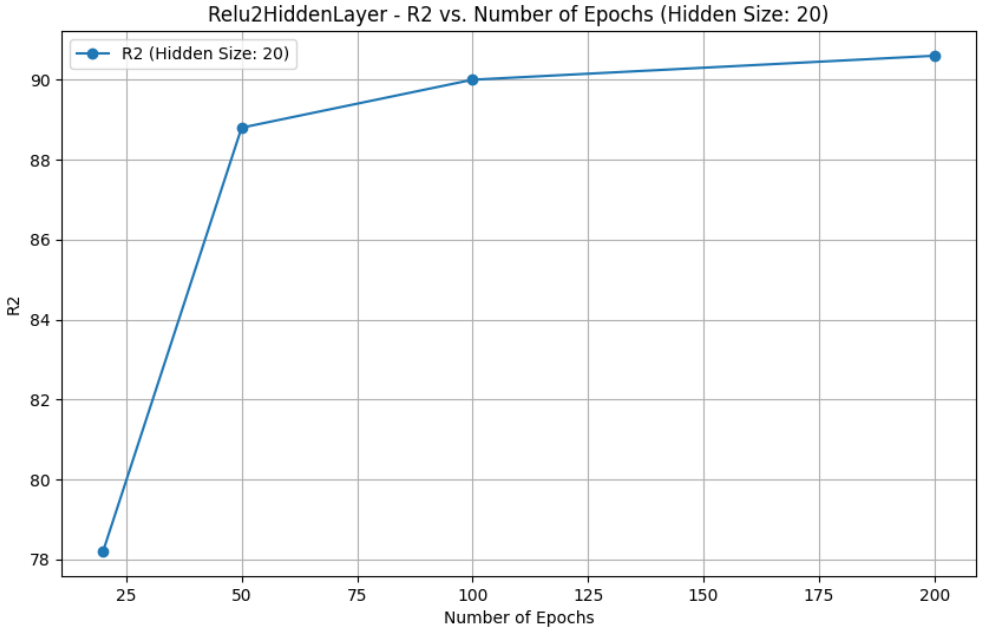

Figure 6: Relu2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 20)

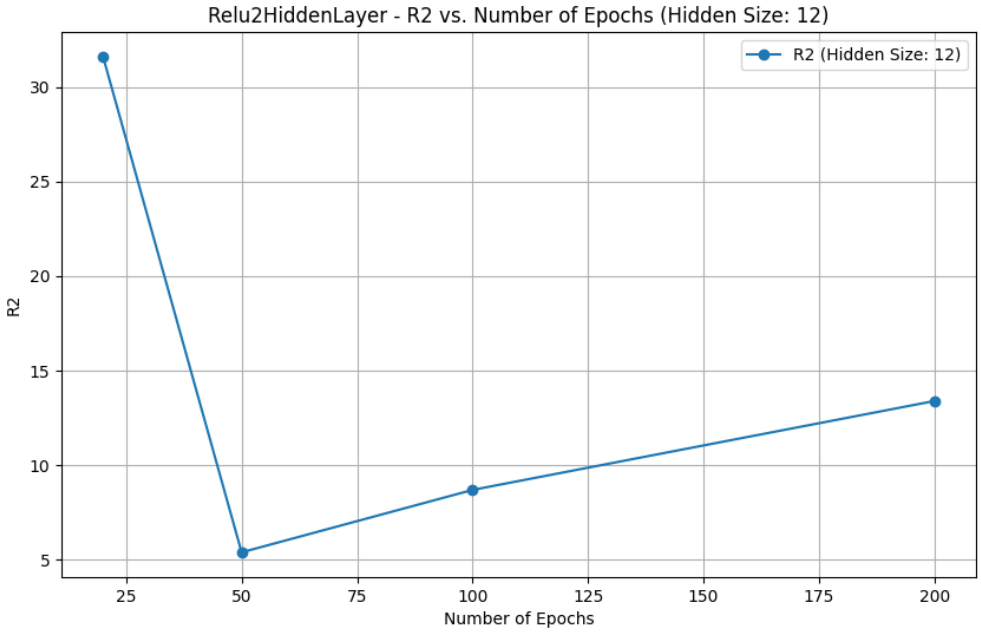

Figure 7: Relu2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 12)

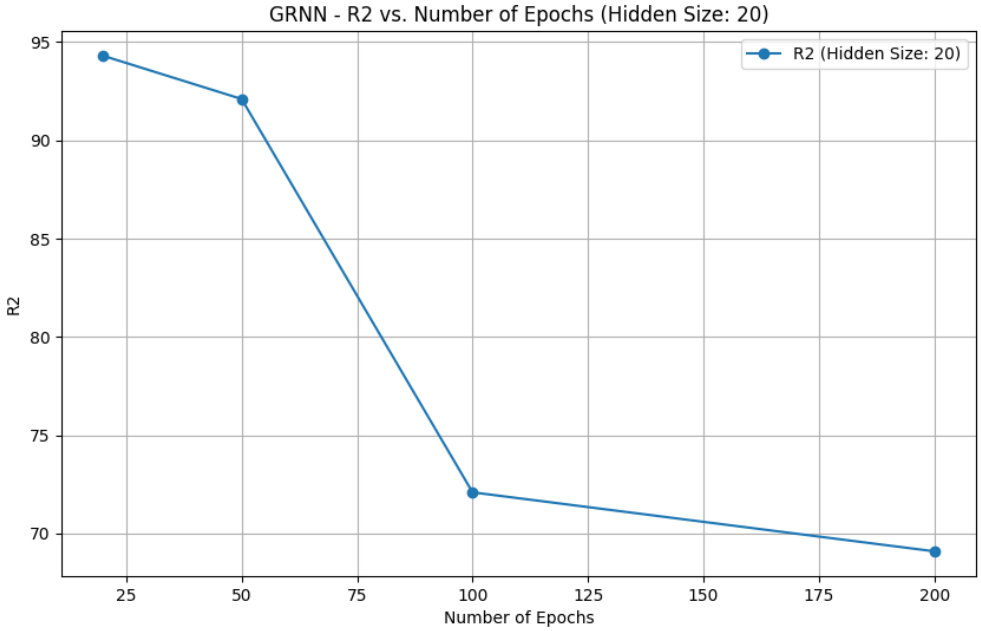

Figure 8: GRNN - R2 vs. Number of Epochs (Hidden Size: 20)

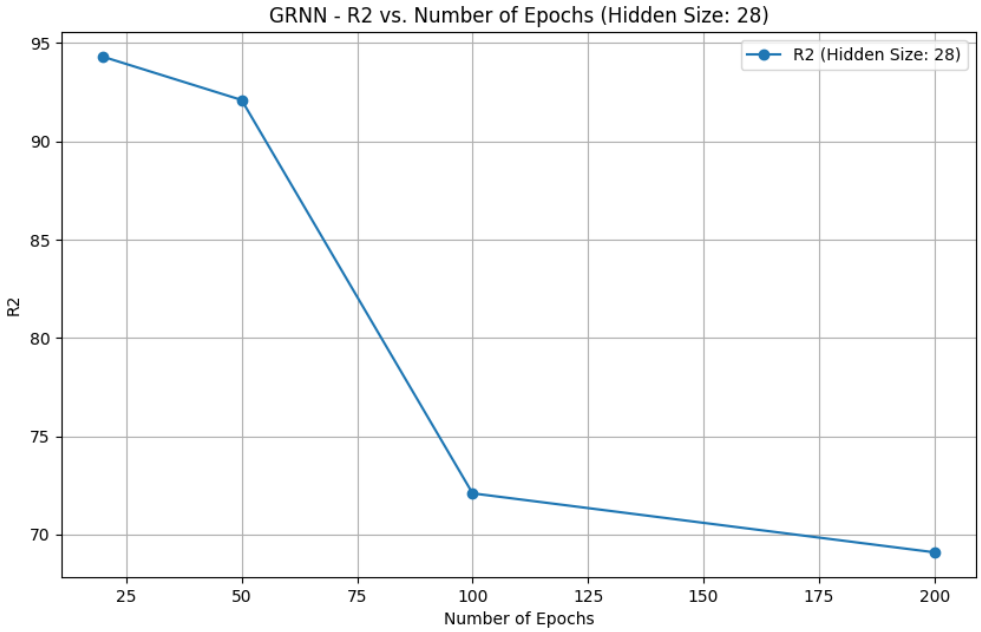

Figure 9: GRNN - R2 vs. Number of Epochs (Hidden Size: 28)

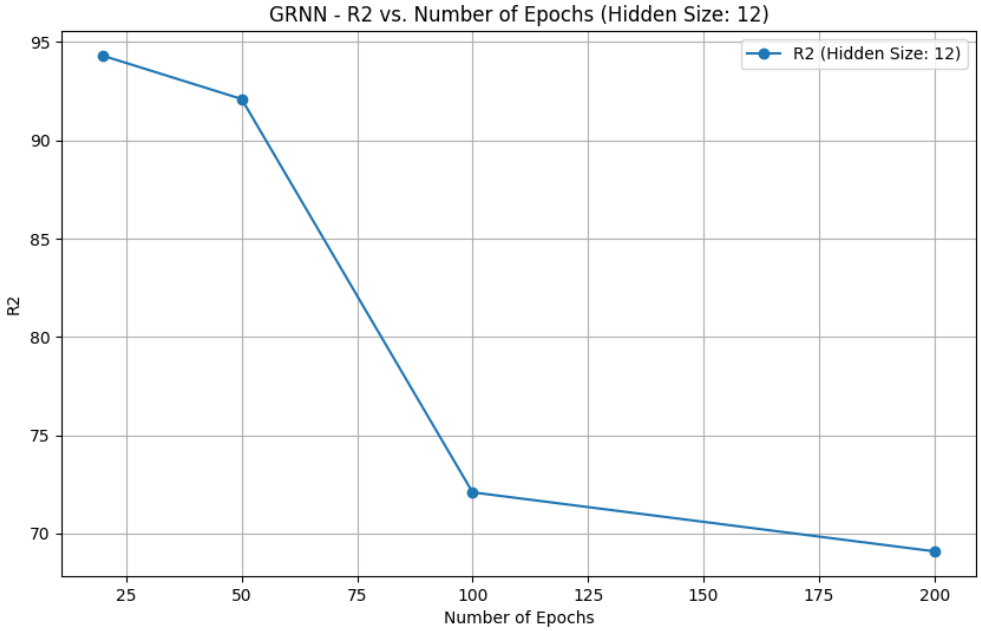

Figure 10: GRNN - R2 vs. Number of Epochs (Hidden Size: 12)

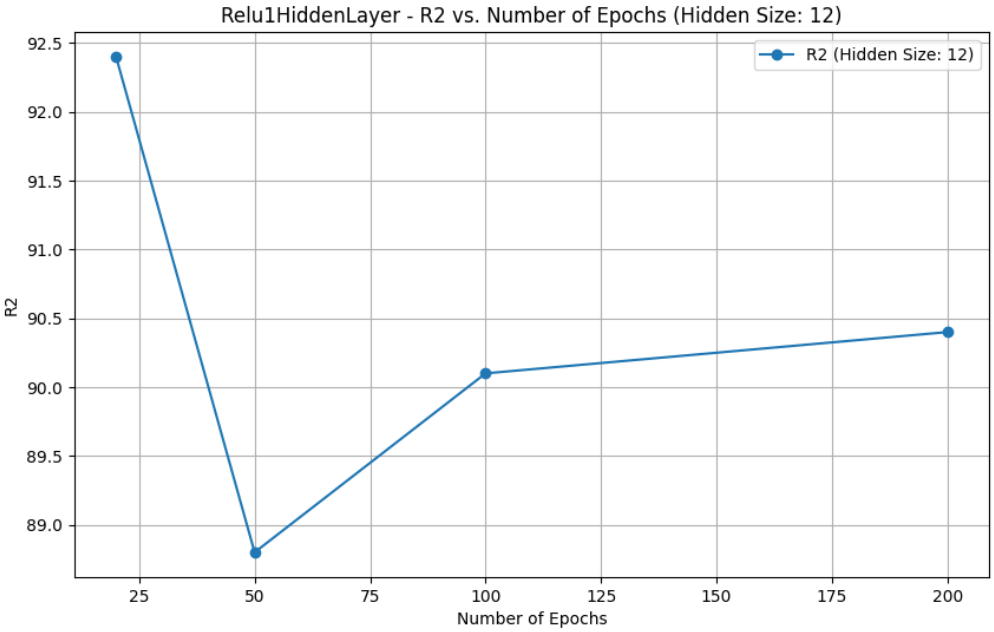

Figure 11: Relu1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 12)

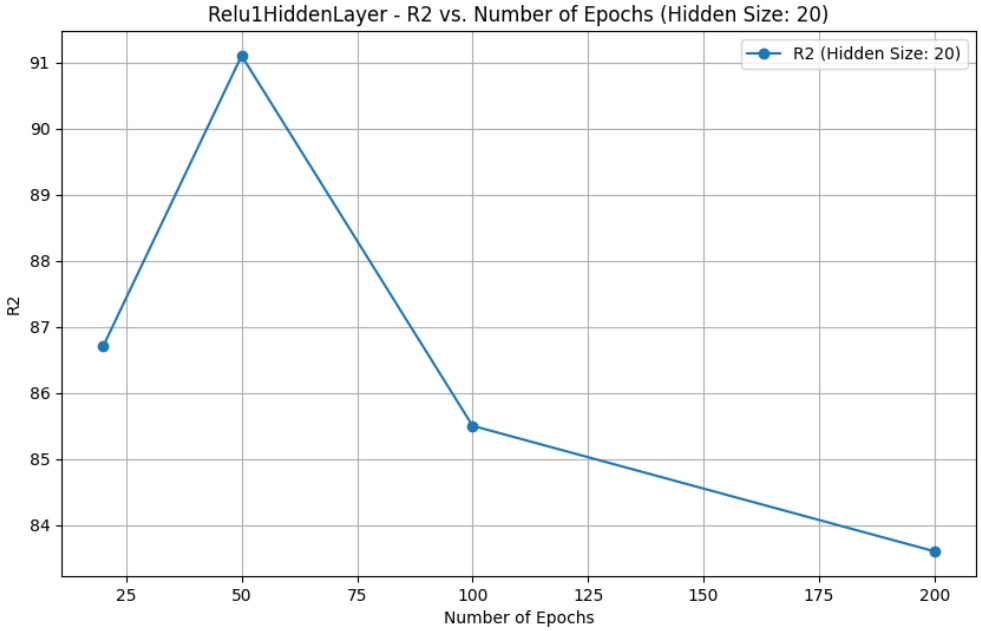

Figure 12: Relu1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 20)

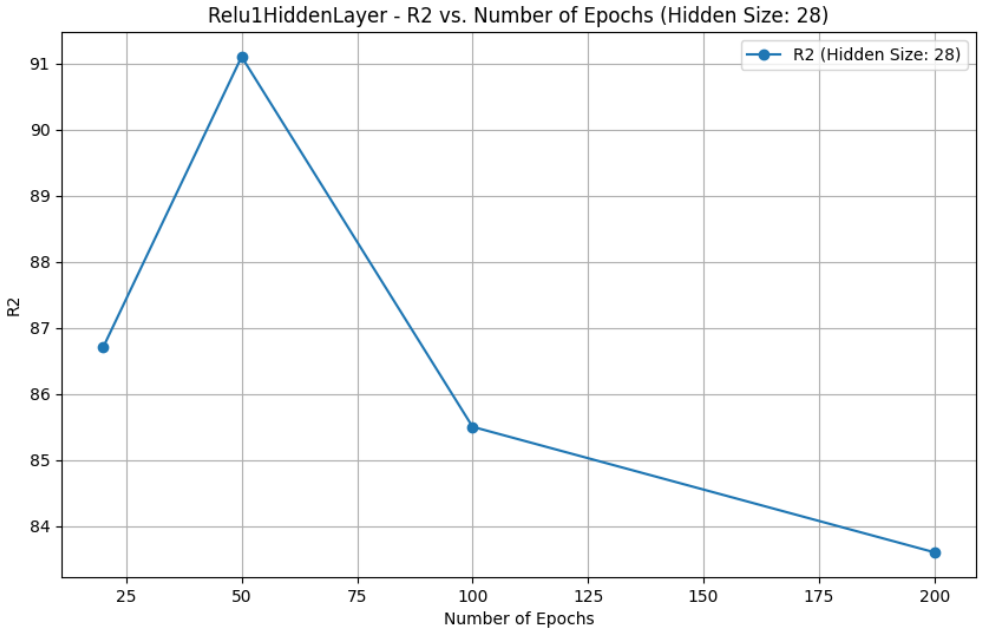

Figure 13: Relu1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 28)

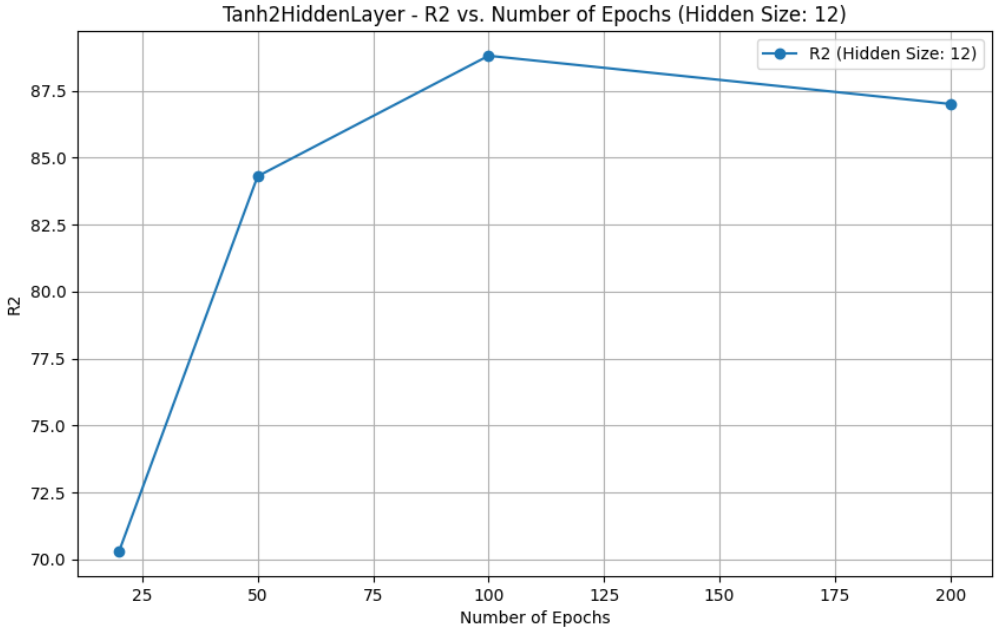

Figure 14: Tanh2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 12)

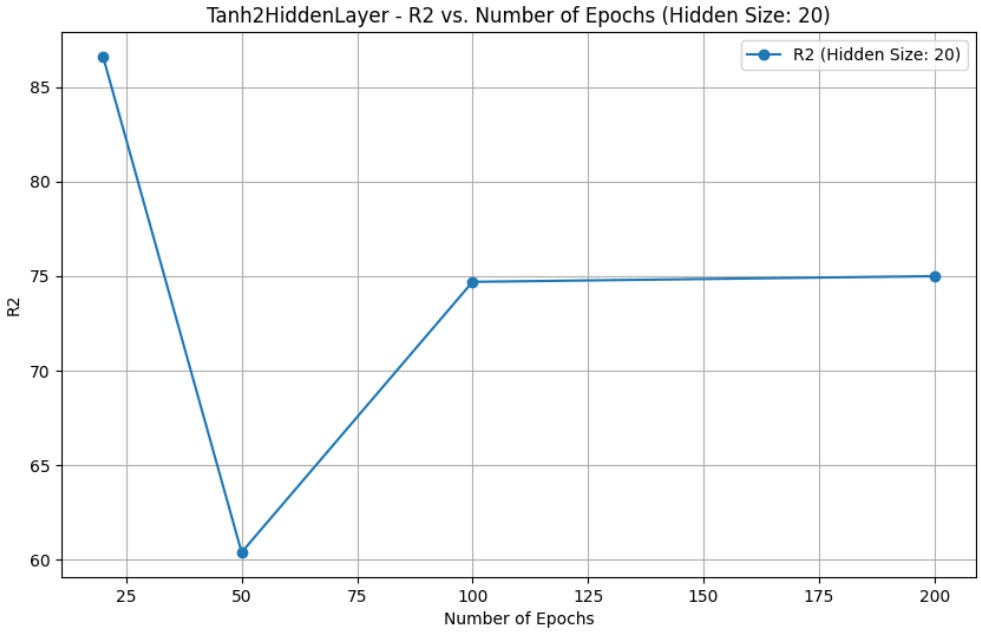

Figure 15: Tanh2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 20)

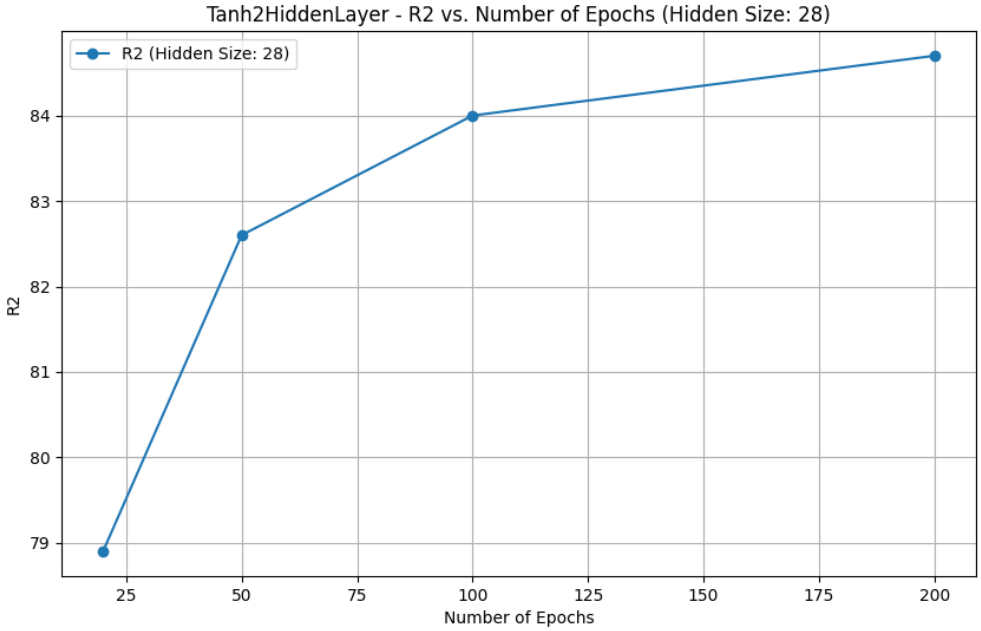

Figure 16: Tanh2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 28)

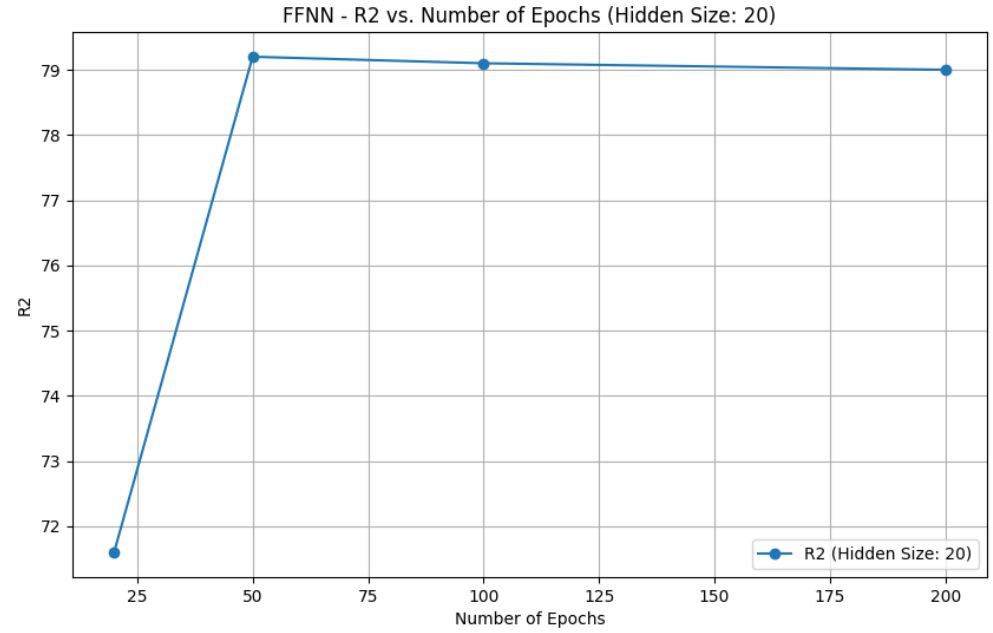

Figure 17: FFNN - R2 vs. Number of Epochs (Hidden Size: 20)

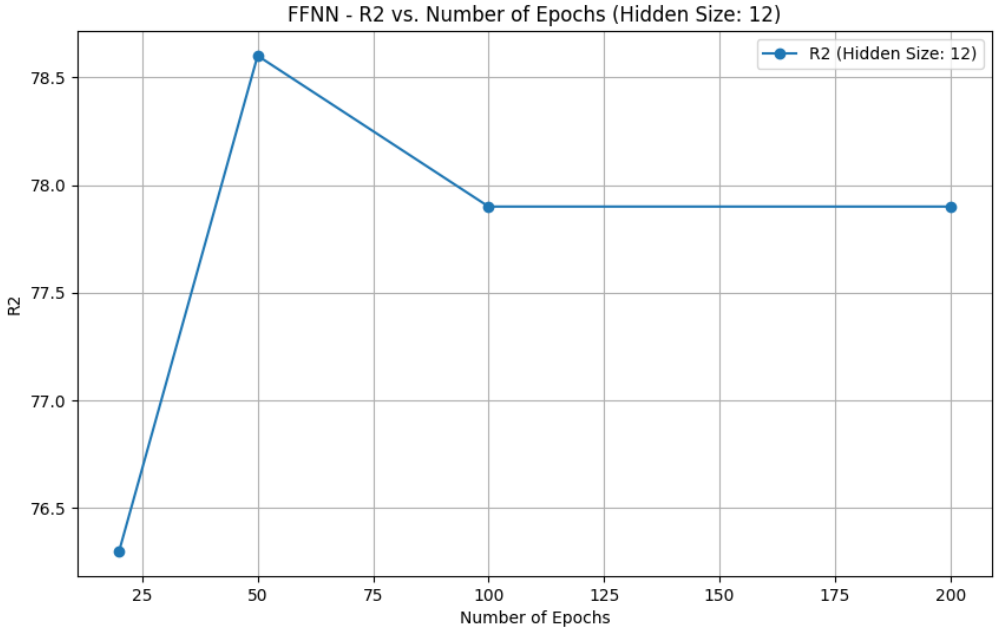

Figure 18: FFNN - R2 vs. Number of Epochs (Hidden Size: 12)

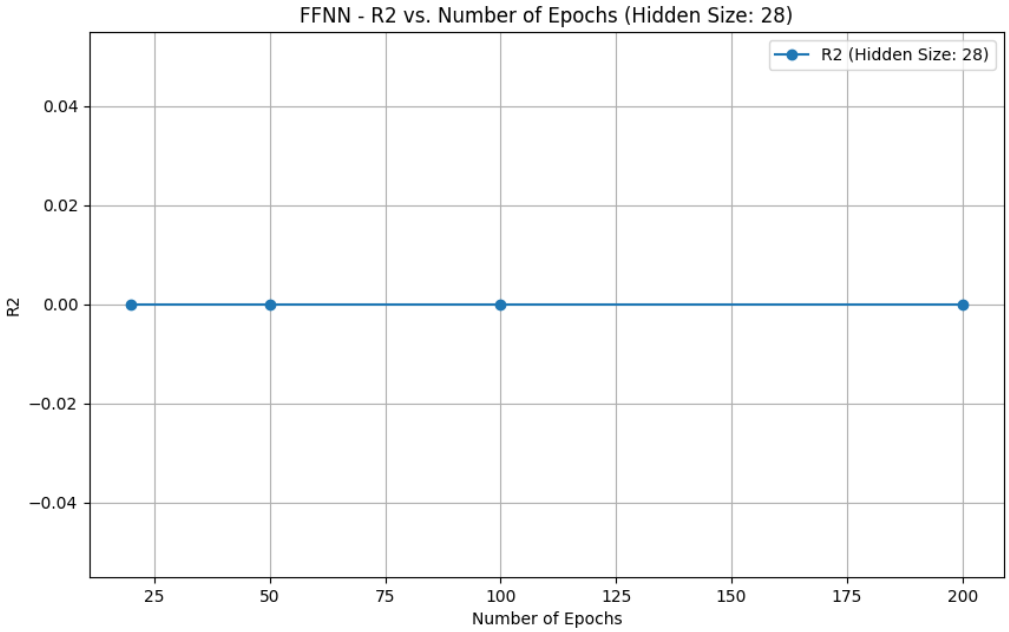

Figure 19: FFNN - R2 vs. Number of Epochs (Hidden Size: 28)

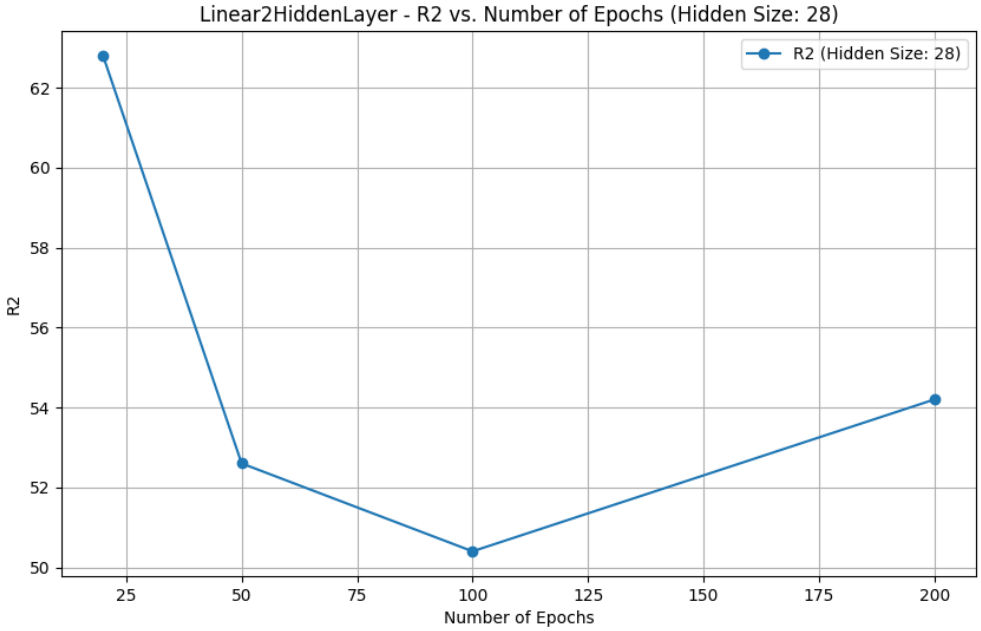

Figure 20: Linear2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 28)

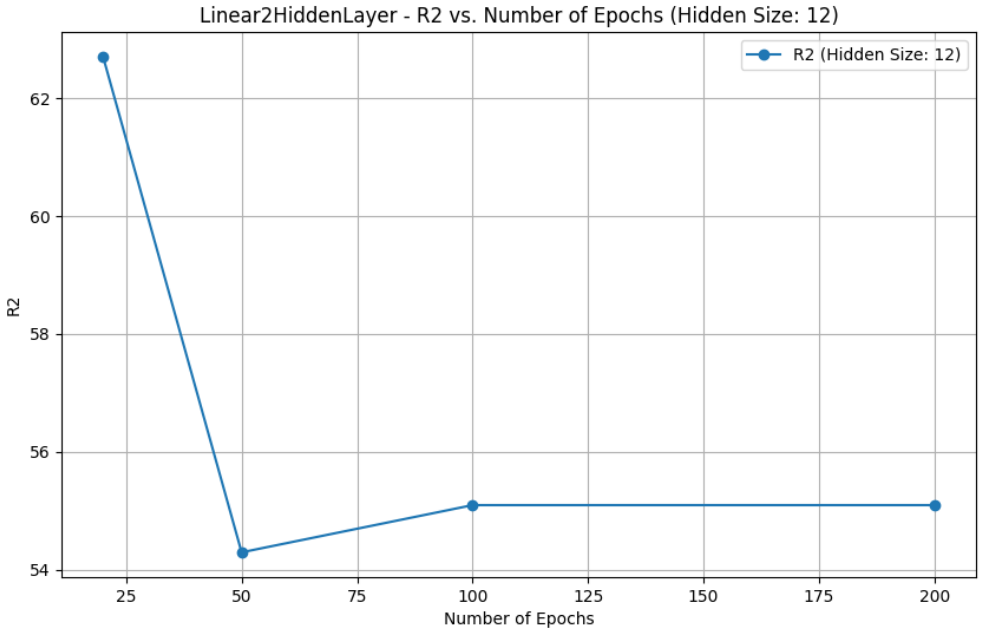

Figure 21: Linear2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 12)

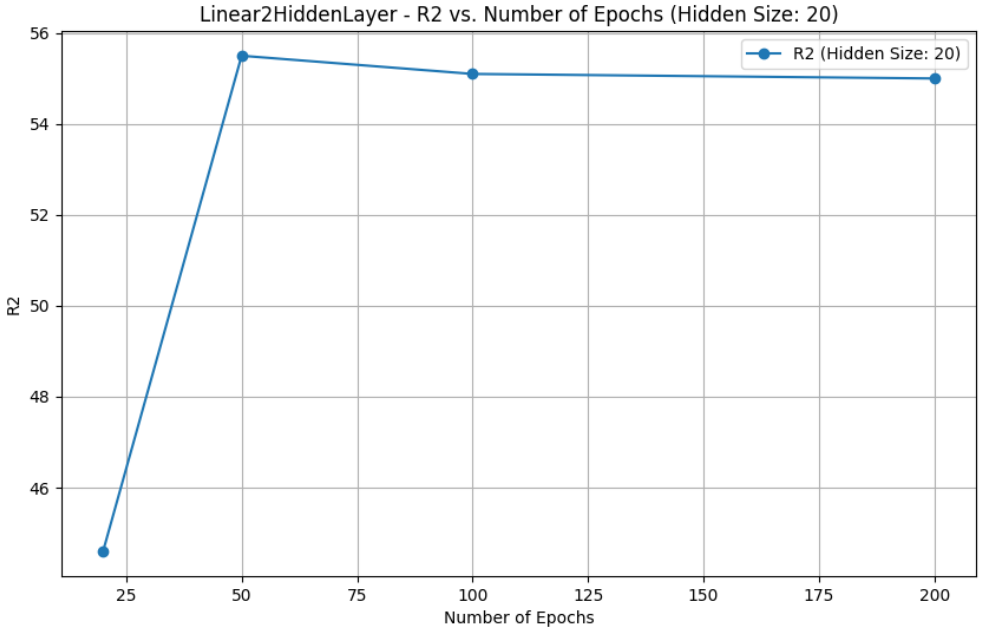

Figure 22: Linear2HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 20)

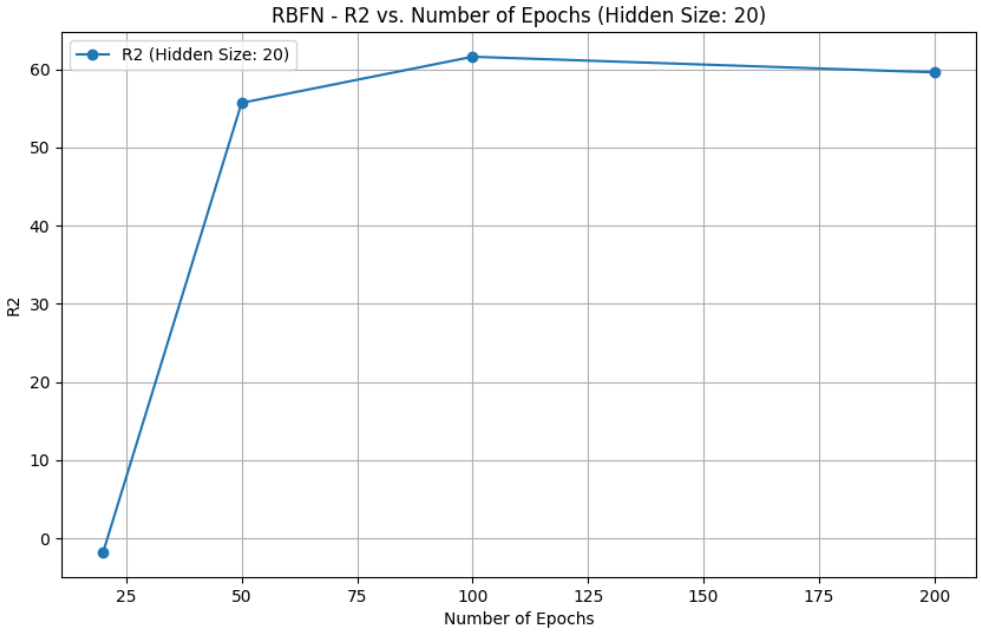

Figure 23: RBFN - R2 vs. Number of Epochs (Hidden Size: 20)

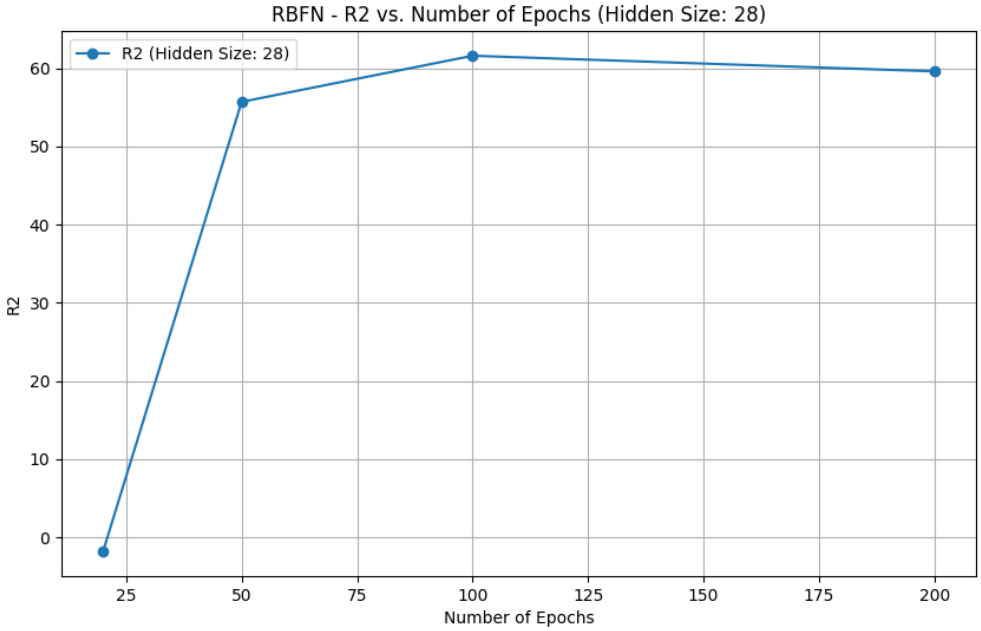

Figure 24: RBFN - R2 vs. Number of Epochs (Hidden Size: 28)

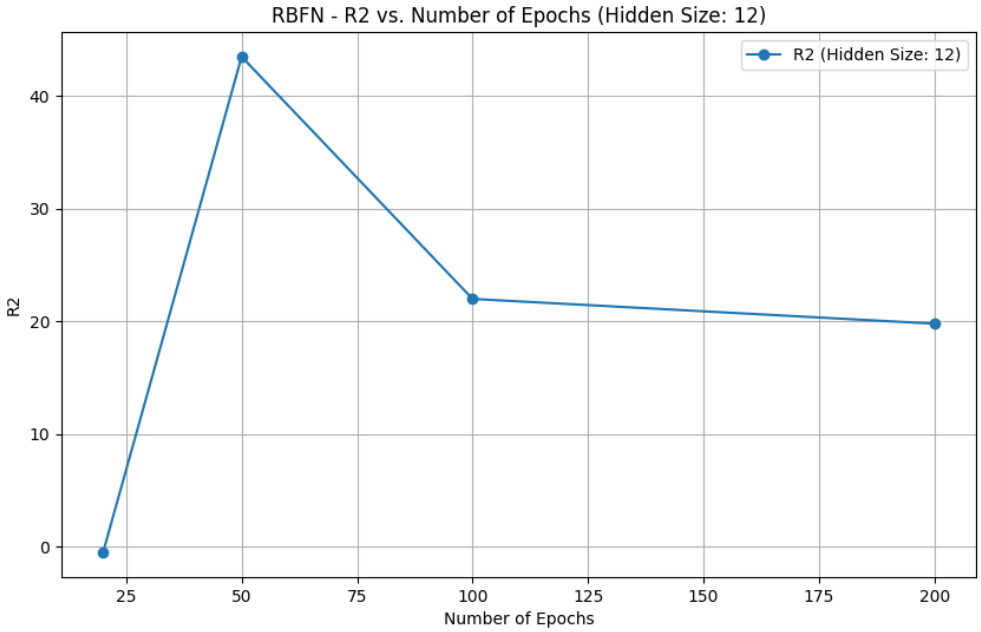

Figure 25: RBFN - R2 vs. Number of Epochs (Hidden Size: 12)

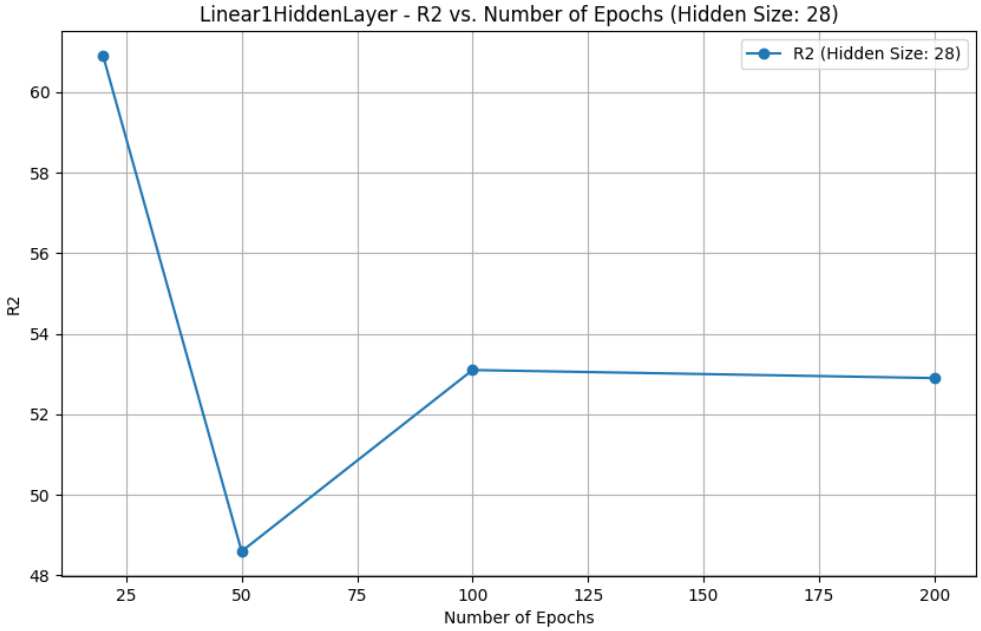

Figure 26: Linear1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 28)

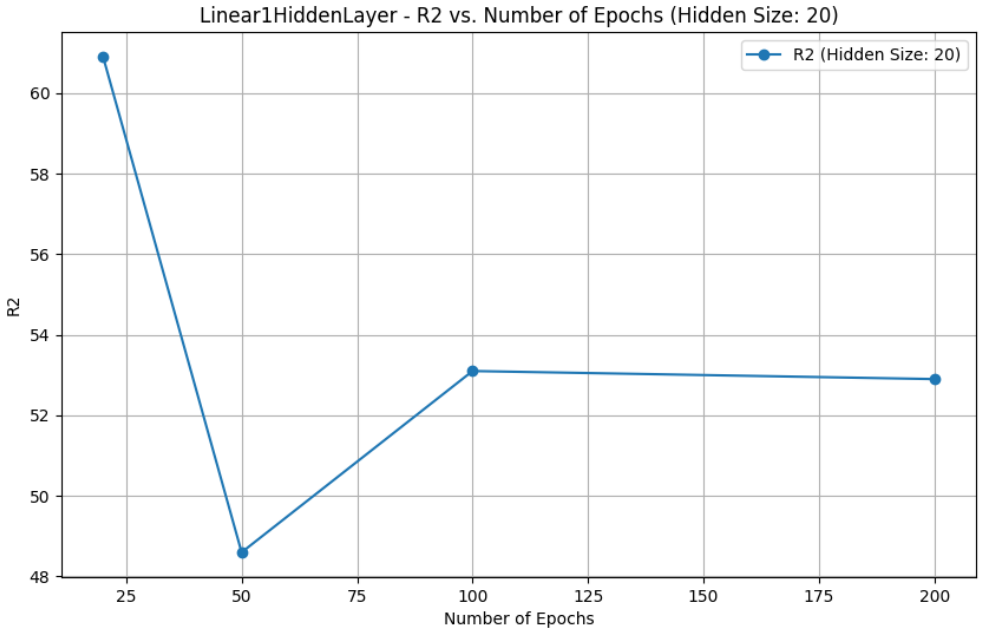

Figure 27: Linear1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 20)

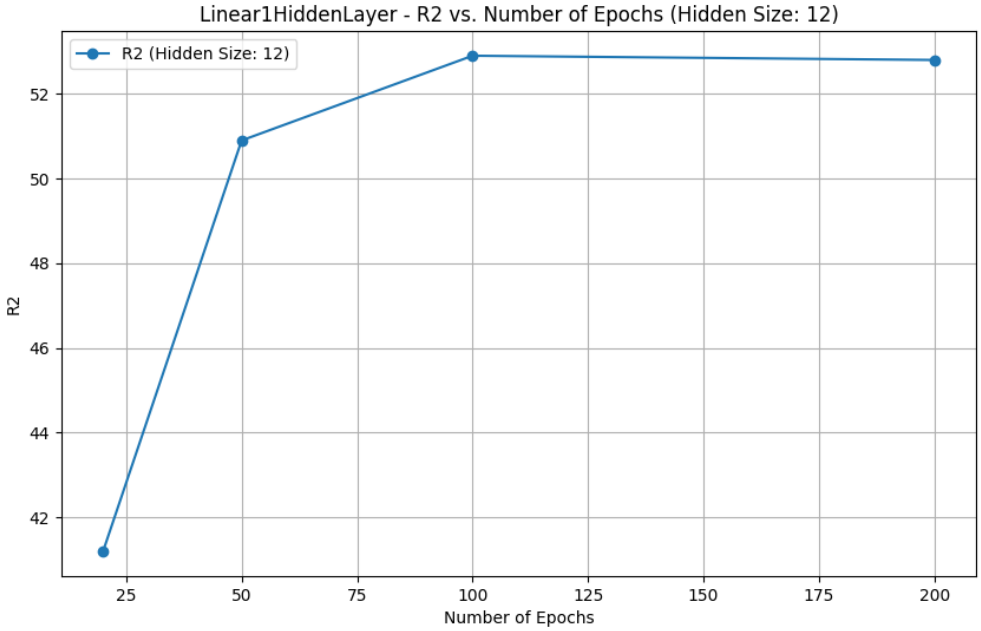

Figure 28: Linear1HiddenLayer - R2 vs. Number of Epochs (Hidden Size: 12)

model	R2	MSE	hidden sizes	total hs	epochs
Tanh1HiddenLayer	97.1 ± 0.0	0.03	[8, 4]	12	20
Relu2HiddenLayer	95.7 ± 0.0	0.04	[15, 10, 3]	28	200
	95.3 ± 0.0	0.04	[15, 10, 3]	28	50
	95.0 ± 0.0	0.04	[15, 10, 3]	28	100
GRNN	94.3 ± 0.0	0.05	[15, 5]	20	20
	94.3 ± 0.0	0.05	[15, 10, 3]	28	20
	94.3 ± 0.0	0.05	[8, 4]	12	20
Tanh1HiddenLayer	92.7 ± 0.0	0.06	[15, 10, 3]	28	100
	92.7 ± 0.0	0.06	[15, 5]	20	100
	92.6 ± 0.0	0.06	[15, 5]	20	200
	92.6 ± 0.0	0.06	[15, 10, 3]	28	200
	92.4 ± 0.0	0.07	[15, 5]	20	50
Relu1HiddenLayer	92.4 ± 0.0	0.07	[8, 4]	12	20
Tanh1HiddenLayer	92.4 ± 0.0	0.07	[15, 10, 3]	28	50
GRNN	92.1 ± 0.0	0.07	[15, 10, 3]	28	50
	92.1 ± 0.0	0.07	[8, 4]	12	50
	92.1 ± 0.0	0.07	[15, 5]	20	50
Tanh1HiddenLayer	91.7 ± 0.0	0.07	[8, 4]	12	50
Relu1HiddenLayer	91.1 ± 0.0	0.08	[15, 5]	20	50
	91.1 ± 0.0	0.08	[15, 10, 3]	28	50
Relu2HiddenLayer	90.6 ± 0.0	0.08	[15, 5]	20	200
Relu1HiddenLayer	90.4 ± 0.0	0.08	[8, 4]	12	200
	90.1 ± 0.0	0.09	[8, 4]	12	100
Relu2HiddenLayer	90.0 ± 0.0	0.09	[15, 5]	20	100
	89.5 ± 0.0	0.09	[15, 10, 3]	28	20
Tanh2HiddenLayer	88.8 ± 0.0	0.1	[8, 4]	12	100
Relu1HiddenLayer	88.8 ± 0.0	0.1	[8, 4]	12	50
Relu2HiddenLayer	88.8 ± 0.0	0.1	[15, 5]	20	50
Tanh2HiddenLayer	87.0 ± 0.0	0.11	[8, 4]	12	200
Relu1HiddenLayer	86.7 ± 0.0	0.12	[15, 10, 3]	28	20
	86.7 ± 0.0	0.12	[15, 5]	20	20
Tanh2HiddenLayer	86.6 ± 0.0	0.12	[15, 5]	20	20
Relu1HiddenLayer	85.5 ± 0.0	0.13	[15, 5]	20	100
	85.5 ± 0.0	0.13	[15, 10, 3]	28	100
Tanh2HiddenLayer	84.7 ± 0.0	0.13	[15, 10, 3]	28	200
	84.3 ± 0.0	0.14	[8, 4]	12	50
	84.0 ± 0.0	0.14	[15, 10, 3]	28	100
Relu1HiddenLayer	83.6 ± 0.0	0.14	[15, 5]	20	200
	83.6 ± 0.0	0.14	[15, 10, 3]	28	200
Tanh2HiddenLayer	82.6 ± 0.0	0.15	[15, 10, 3]	28	50
Tanh1HiddenLayer	80.9 ± 0.0	0.17	[15, 5]	20	20
	80.9 ± 0.0	0.17	[15, 10, 3]	28	20
	80.3 ± 0.0	0.17	[8, 4]	12	100
FFNN	79.2 ± 0.0	0.18	[15, 5]	20	50
	79.1 ± 0.0	0.18	[15, 5]	20	100
	79.0 ± 0.0	0.18	[15, 5]	20	200
Tanh2HiddenLayer	78.9 ± 0.0	0.18	[15, 10, 3]	28	20
Tanh1HiddenLayer	78.6 ± 0.0	0.19	[8, 4]	12	200
FFNN	78.6 ± 0.0	0.19	[8, 4]	12	50
Relu2HiddenLayer	78.2 ± 0.0	0.19	[15, 5]	20	20
FFNN	77.9 ± 0.0	0.19	[8, 4]	12	100
	77.9 ± 0.0	0.19	[8, 4]	12	200
	76.3 ± 0.0	0.21	[8, 4]	12	20
Tanh2HiddenLayer	75.0 ± 0.0	0.22	[15, 5]	20	200
	74.7 ± 0.0	0.22	[15, 5]	20	100
GRNN	72.1 ± 0.0	0.24	[15, 10, 3]	28	100
	72.1 ± 0.0	0.24	[8, 4]	12	100
	72.1 ± 0.0	0.24	[15, 5]	20	100
FFNN	71.6 ± 0.0	0.25	[15, 5]	20	20
Tanh2HiddenLayer	70.3 ± 0.0	0.26	[8, 4]	12	20
GRNN	69.1 ± 0.0	0.27	[15, 10, 3]	28	200
	69.1 ± 0.0	0.27	[8, 4]	12	200
	69.1 ± 0.0	0.27	[15, 5]	20	200
Linear2HiddenLayer	62.8 ± 0.0	0.33	[15, 10, 3]	28	20
	62.7 ± 0.0	0.33	[8, 4]	12	20
RBFN	61.6 ± 0.0	0.34	[15, 5]	20	100

features	R2
flow_rate1, conc_nano1, Kfluid1, heat_flux1, X_D1, flow_rate2, conc_nano2, Kfluid2, heat_flux2, X_D2	82.69
conc_nano1, Kfluid1, heat_flux1, X_D1, flow_rate2, conc_nano2, Kfluid2, heat_flux2, X_D2	62.45
flow_rate1, Kfluid1, heat_flux1, X_D1, flow_rate2, conc_nano2, Kfluid2, heat_flux2, X_D2	81.63
flow_rate1, conc_nano1, heat_flux1, X_D1, flow_rate2, conc_nano2, Kfluid2, heat_flux2, X_D2	73.64
flow_rate1, conc_nano1, Kfluid1, X_D1, flow_rate2, conc_nano2, Kfluid2, heat_flux2, X_D2	72.94
flow_rate1, conc_nano1, Kfluid1, heat_flux1, flow_rate2, conc_nano2, Kfluid2, heat_flux2, X_D2	67.45
flow_rate1, conc_nano1, Kfluid1, heat_flux1, X_D1, conc_nano2, Kfluid2, heat_flux2, X_D2	68.03
flow_rate1, conc_nano1, Kfluid1, heat_flux1, X_D1, flow_rate2, Kfluid2, heat_flux2, X_D2	76.57
flow_rate1, conc_nano1, Kfluid1, heat_flux1, X_D1, flow_rate2, conc_nano2, heat_flux2, X_D2	38.28
flow_rate1, conc_nano1, Kfluid1, heat_flux1, X_D1, flow_rate2, conc_nano2, Kfluid2, X_D2	69.39
flow_rate1, conc_nano1, Kfluid1, heat_flux1, X_D1, flow_rate2, conc_nano2, Kfluid2, heat_flux2	81.61

Table 2: Results of Backward Feature Elimination

features	R2
X_D1	14.85
flow_rate2	27.69
conc_nano2	11.15
Kfluid2	62.66
heat_flux2	-4.92
flow_rate1, Kfluid2	75.33
conc_nano1, Kfluid2	64.49
Kfluid1, Kfluid2	67.9
heat_flux1, Kfluid2	74.3
X_D1, Kfluid2	67.3
flow_rate2, Kfluid2	9.94
conc_nano2, Kfluid2	87.59
heat_flux2, Kfluid2	56.8
X_D2, Kfluid2	67.59
flow_rate1, Kfluid2, conc_nano2	60.42
conc_nano1, Kfluid2, conc_nano2	78.36
Kfluid1, Kfluid2, conc_nano2	79.88
heat_flux1, Kfluid2, conc_nano2	90.37
X_D1, Kfluid2, conc_nano2	84.51
flow_rate2, Kfluid2, conc_nano2	65.14
heat_flux2, Kfluid2, conc_nano2	57.1
X_D2, Kfluid2, conc_nano2	54.6
flow_rate1, Kfluid2, conc_nano2, heat_flux1	62.62
conc_nano1, Kfluid2, conc_nano2, heat_flux1	92.87
Kfluid1, Kfluid2, conc_nano2, heat_flux1	80.94
X_D1, Kfluid2, conc_nano2, heat_flux1	87.63
flow_rate2, Kfluid2, conc_nano2, heat_flux1	82.76
heat_flux2, Kfluid2, conc_nano2, heat_flux1	55.75
X_D2, Kfluid2, conc_nano2, heat_flux1	75.43
flow_rate1, Kfluid2, conc_nano2, heat_flux1, conc_nano1	49.56
Kfluid1, Kfluid2, conc_nano2, heat_flux1, conc_nano1	93.06
X_D1, Kfluid2, conc_nano2, heat_flux1, conc_nano1	87.49
flow_rate2, Kfluid2, conc_nano2, heat_flux1, conc_nano1	69.35
heat_flux2, Kfluid2, conc_nano2, heat_flux1, conc_nano1	65.5
X_D2, Kfluid2, conc_nano2, heat_flux1, conc_nano1	64.18
flow_rate1, Kfluid2, conc_nano2, heat_flux1, conc_nano1, Kfluid1	84.19
X_D1, Kfluid2, conc_nano2, heat_flux1, conc_nano1, Kfluid1	87.54
flow_rate2, Kfluid2, conc_nano2, heat_flux1, conc_nano1, Kfluid1	76.61
heat_flux2, Kfluid2, conc_nano2, heat_flux1, conc_nano1, Kfluid1	71.81
X_D2, Kfluid2, conc_nano2, heat_flux1, conc_nano1, Kfluid1	77.34

Table 3: Results of Forward Feature Selection for different features

Feature	Weight Importance
X_D2	0.681455
X_D1	0.617036
heat_flux2	0.613336
heat_flux1	0.612263
Kfluid2	0.512448
conc_nano2	0.490265
flow_rate1	0.426227
Kfluid1	0.419663
conc_nano1	0.390698

Table 4: Results of Weight Analysis

Feature	Sensitivity	Variance
Kfluid2	4.82179	401.356
heat_flux2	3.89074	224.65
X_D1	-1.47476	501.868
X_D2	-1.64904	234.985
Kfluid1	-7.38787	462.004
flow_rate1	-11.5723	420.514
flow_rate2	-17.386	165.634
conc_nano1	-19.2583	623.708
conc_nano2	-23.7143	34.6234
heat_flux1	-25.1771	106.623

Table 5: Results of Jackknife Sensitivity Analysis