

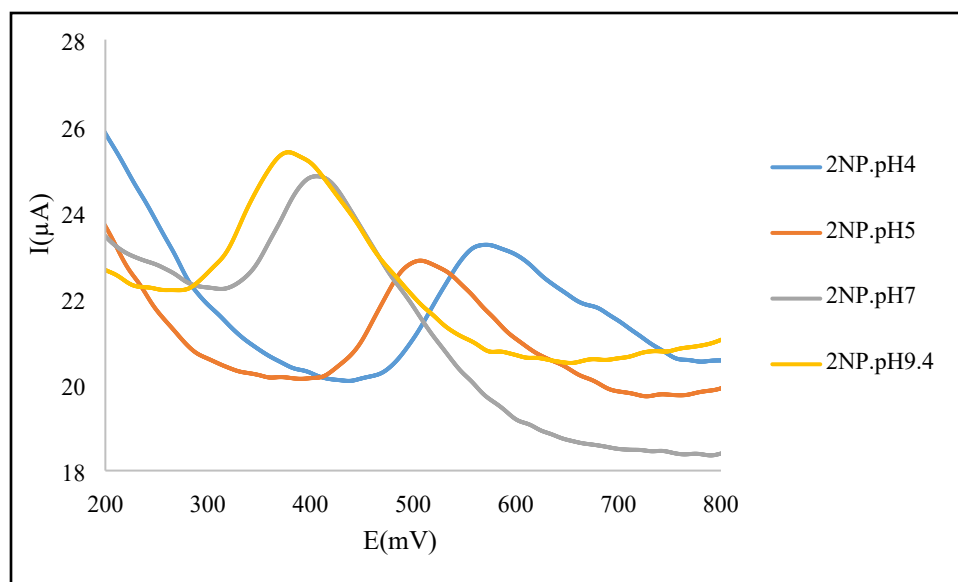


Fig. S1. SWAS voltammograms of 2-NP (30ppm) at the Ni-MOF74/ Fe₃O₄/SiO₂/NH₂/ β-CD / GCE surface in the PBS (0.1M) at different pH (4.00-9.40), scan rate 100 mVs^{-1} , duration time 120 s , Pulse=500 mV.

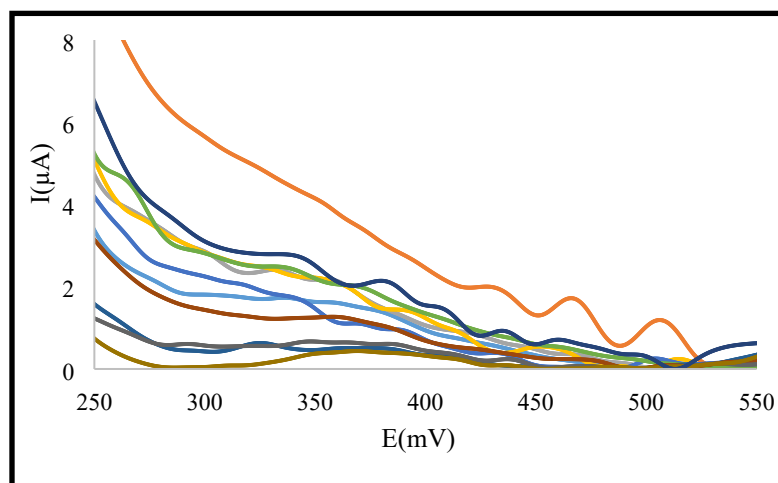
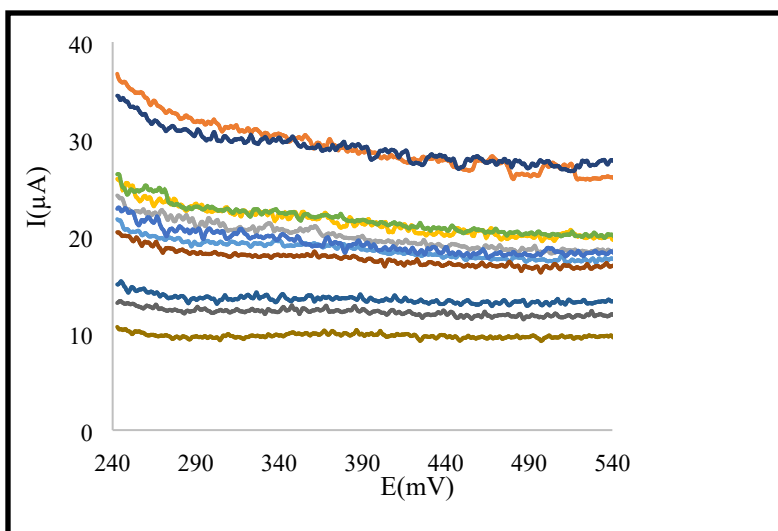


Fig. S2. SWAS voltammograms of 2-NP (10ppm) at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}$ / GCE surface in the PBS (0.1M, pH= 9.40) at different scan rate ($27.5\text{-}112\text{mVs}^{-1}$) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

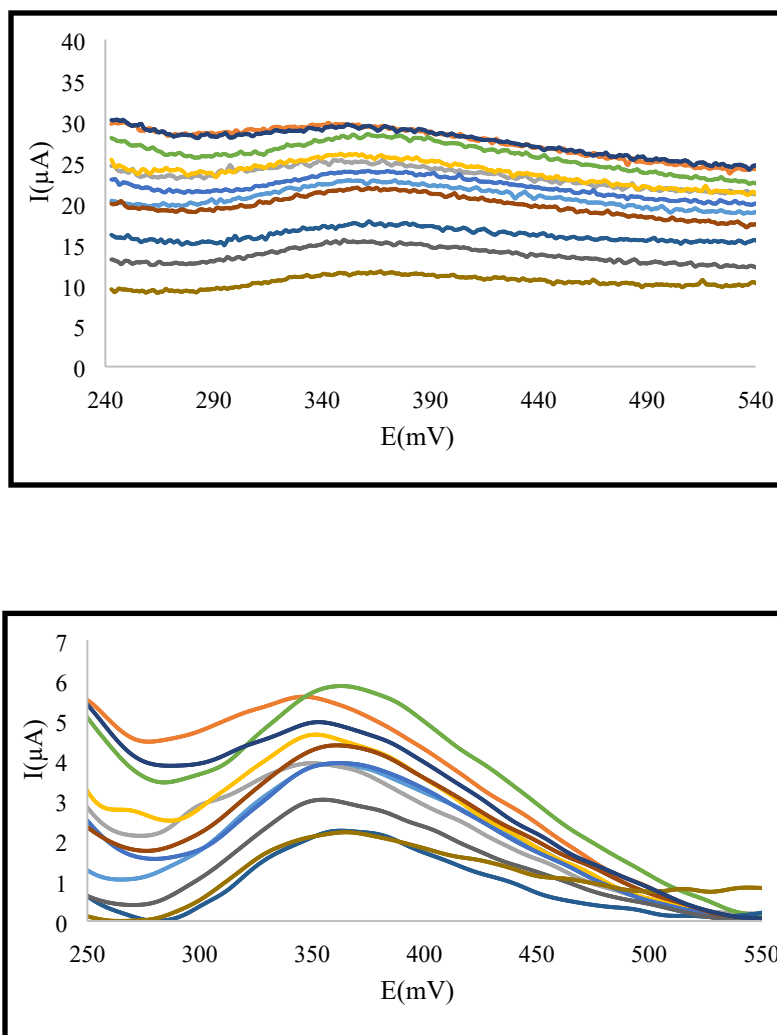


Fig. S3. SWAS voltammograms of 2-NP (30ppm) at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}$ / GCE surface in the PBS (0.1M, pH= 9.40) at different scan rate ($27.5\text{-}112\text{mvs}^{-1}$) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

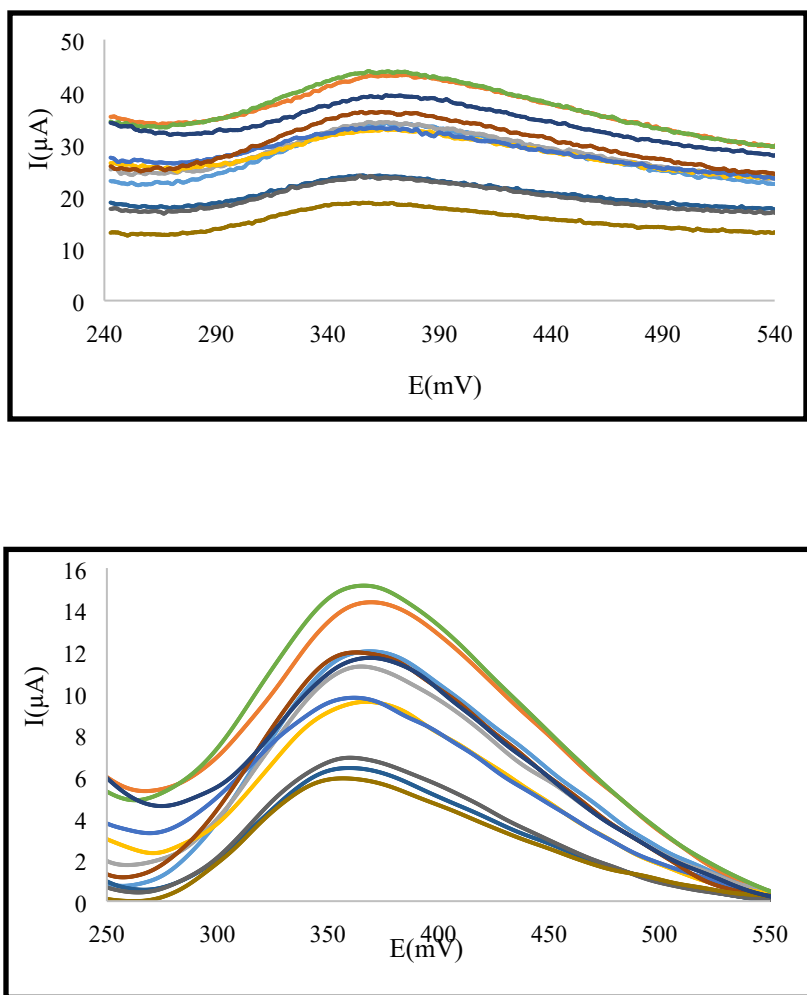


Fig. S4. SWAS voltammograms of 2-NP (100ppm) at the Ni-MOF74/ $Fe_3O_4/SiO_2/NH_2/ \beta$ -CD / GCE surface in the PBS (0.1M, pH= 9.40) at different scan rate (27.5 - 112 mVs^{-1}) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

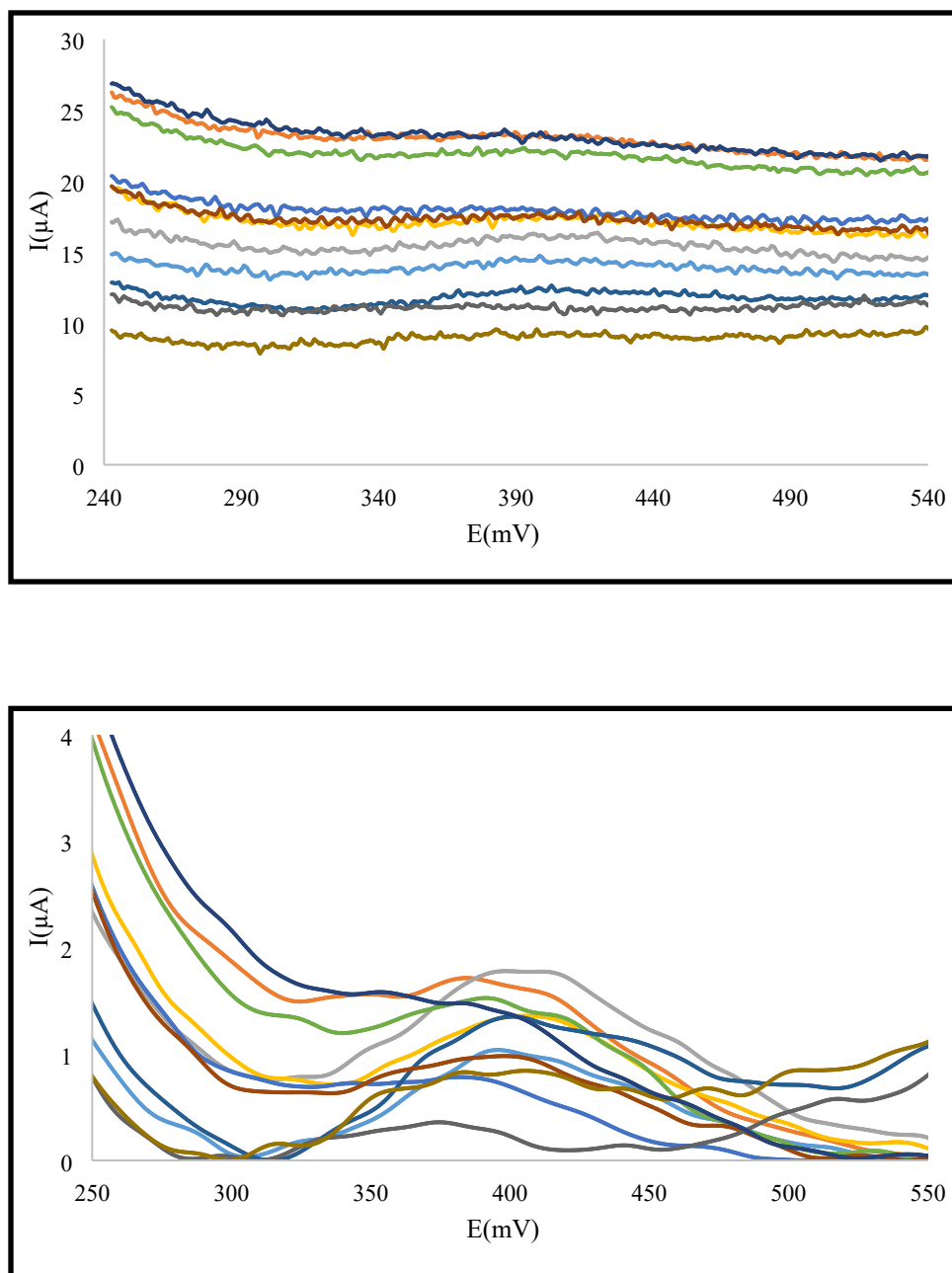


Fig. S5. SWAS voltammograms of 4-NP (10ppm) at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}$ / GCE surface in the PBS (0.1M, pH= 9.40) at different scan rate ($27.5\text{-}112\text{mVs}^{-1}$) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

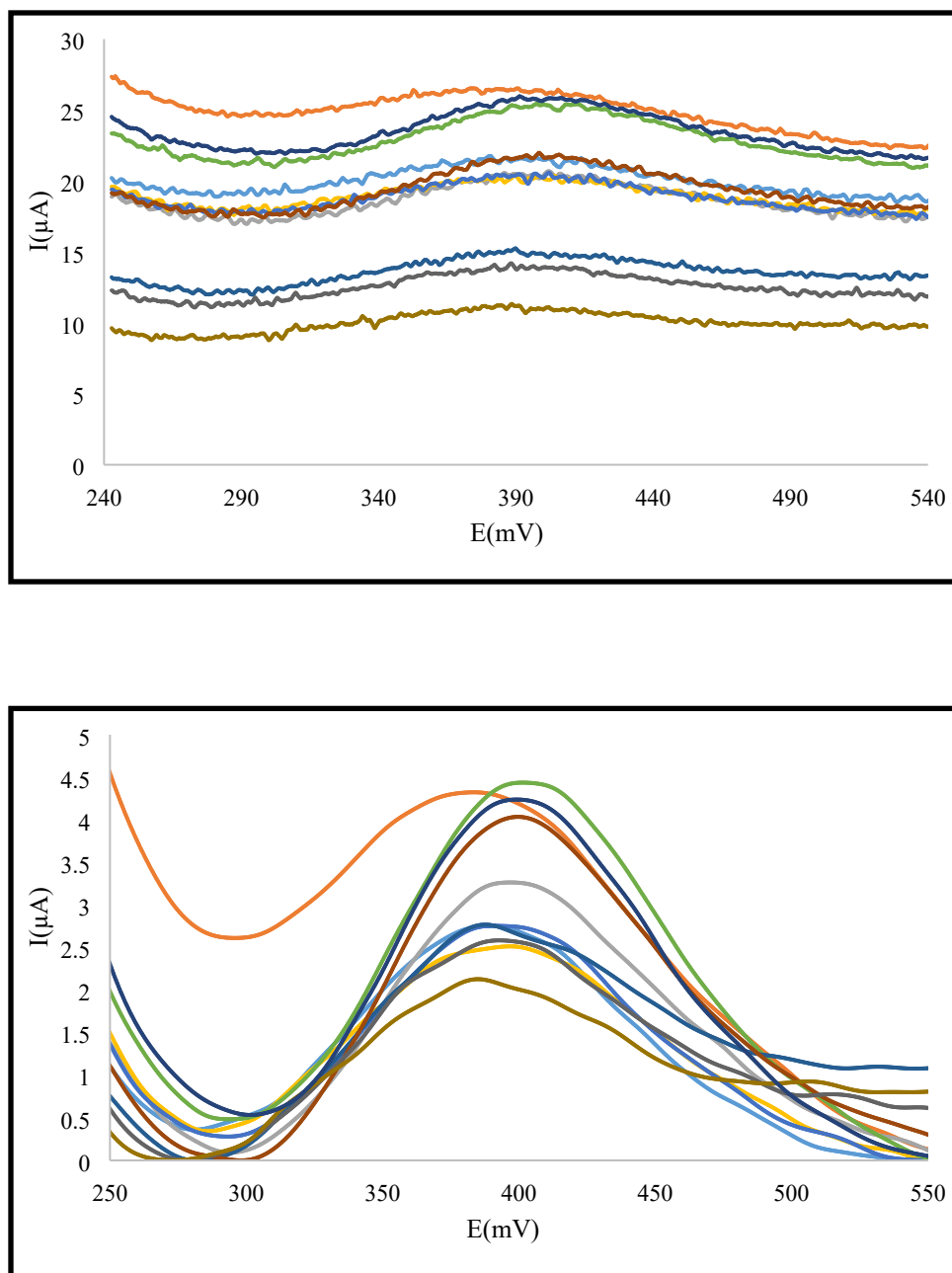


Fig. S6. SWAS voltammograms of 4-NP (30ppm) at the Ni-MOF74/ $Fe_3O_4/SiO_2/NH_2/\beta$ -CD / GCE surface in the PBS (0.1M, pH= 9.40) at different scan rate (27.5 - $112 mVs^{-1}$) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

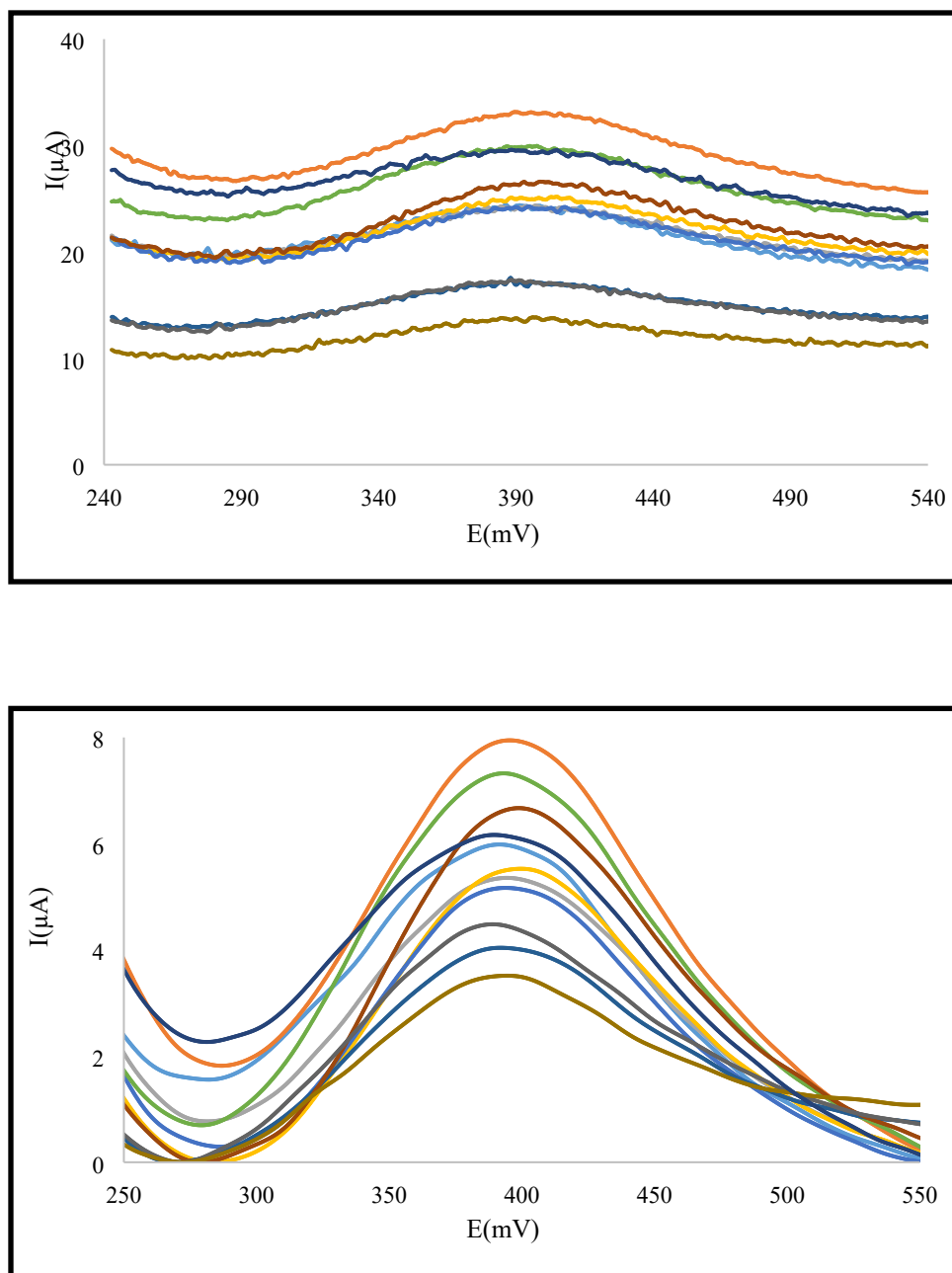


Fig. S7. SWAS voltammograms of 4-NP (60ppm) at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}/\text{GCE}$ surface in the PBS (0.1M, pH= 9.40) at different scan rate ($27.5\text{-}112\text{mvs}^{-1}$) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

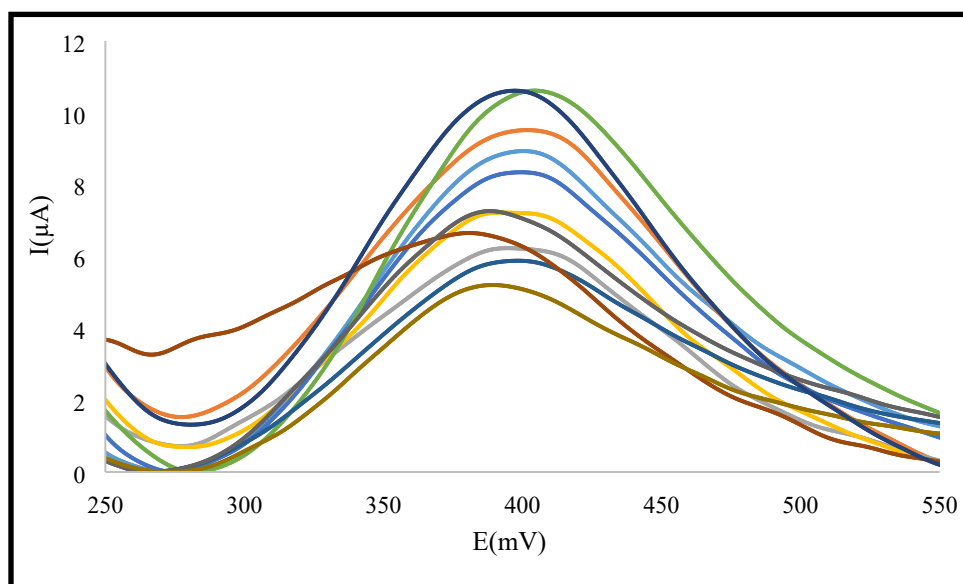
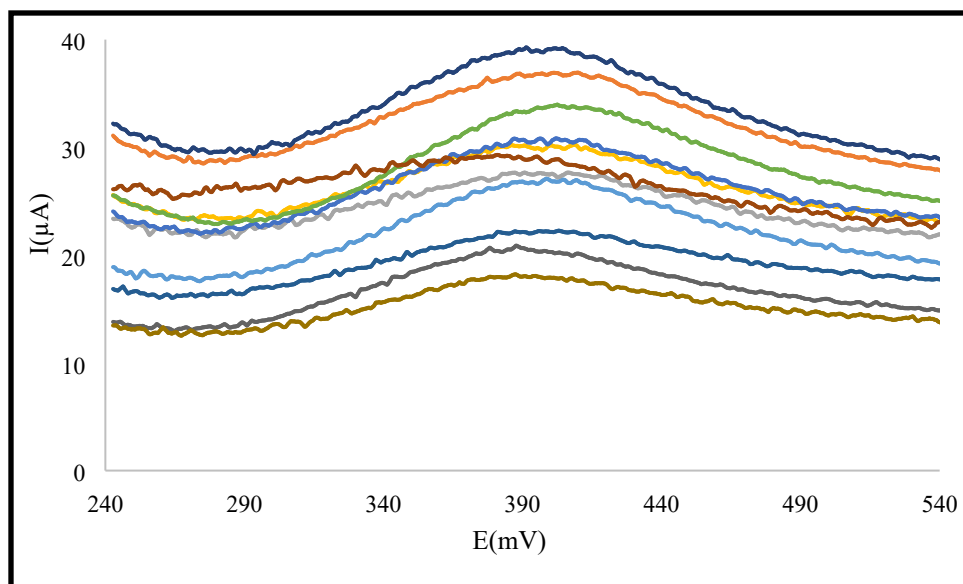


Fig. S8. SWAS voltammograms of 4-NP (100ppm) at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}$ / GCE surface in the PBS (0.1M, pH= 9.40) at different scan rate ($27.5\text{-}112\text{ mVs}^{-1}$) and different duration time (11-240 s), Pulse=500 mV. Experimental data (a) and Pretreated Data (b)

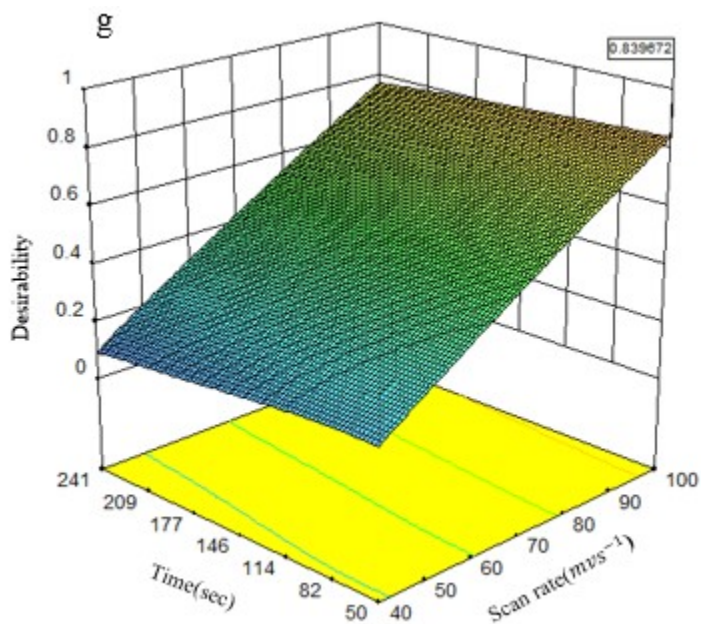


Fig.S9. 3-D desirability plot vs. scan rate and duration time to optimize 2-NP and 4-NP oxidation process

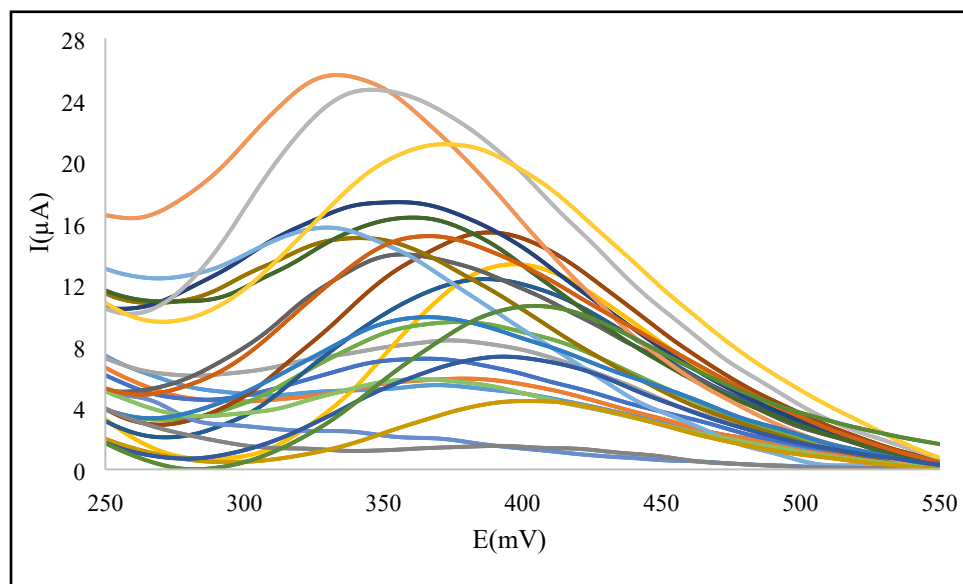


Fig. S10. SWAS voltammograms of 2-NP and 4NP at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}$ / GCE surface in the PBS (0.1M, pH= 9.40) at scan rate 100mVs^{-1} and duration time 50s, Pulse=500 mv, for to total data set

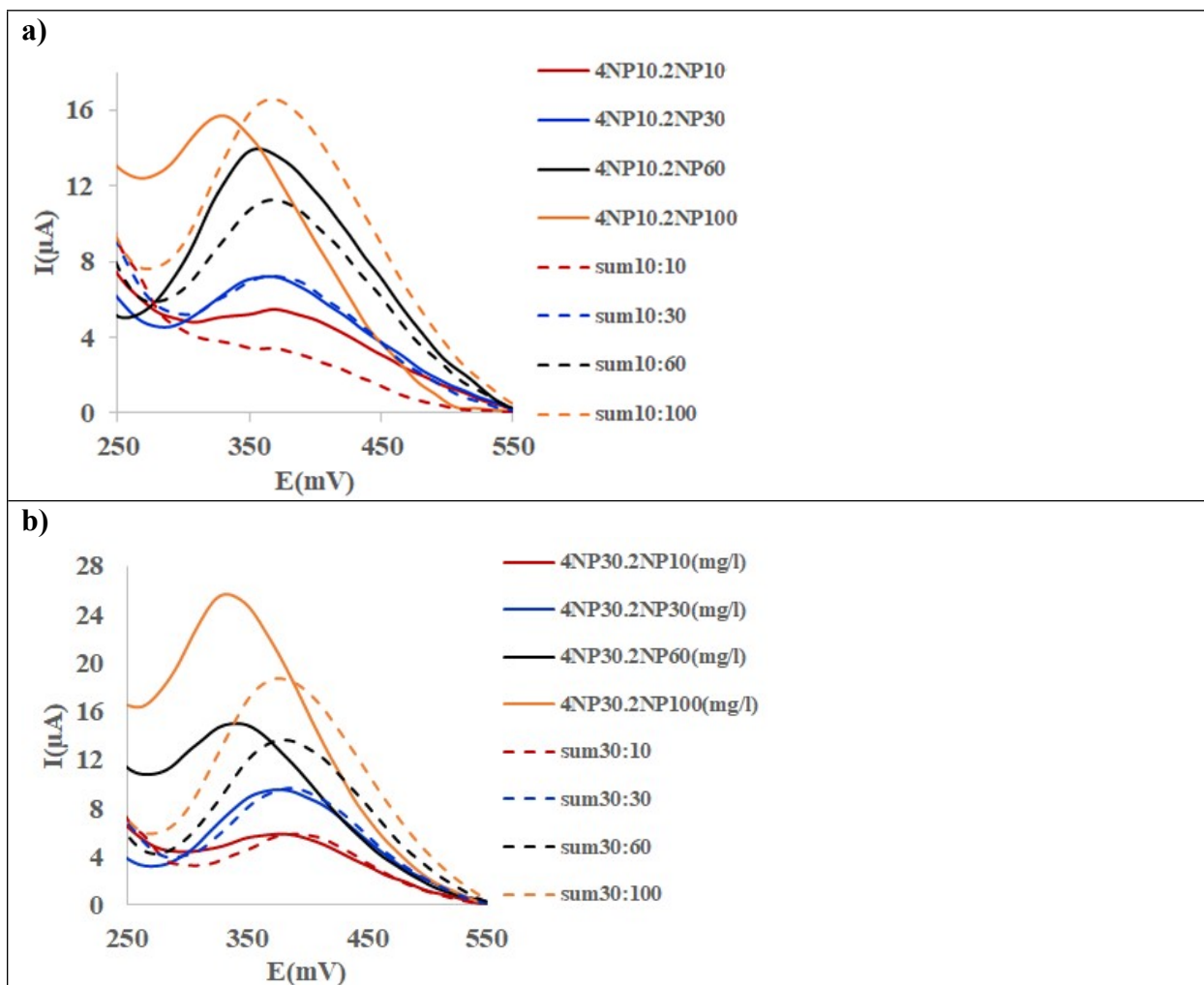


Fig.S11. SWAS voltammograms of (a): 4-NP (10ppm) in 2-NP (10-100ppm). (b): 4-NP (30ppm) in 2-NP (10-100ppm).

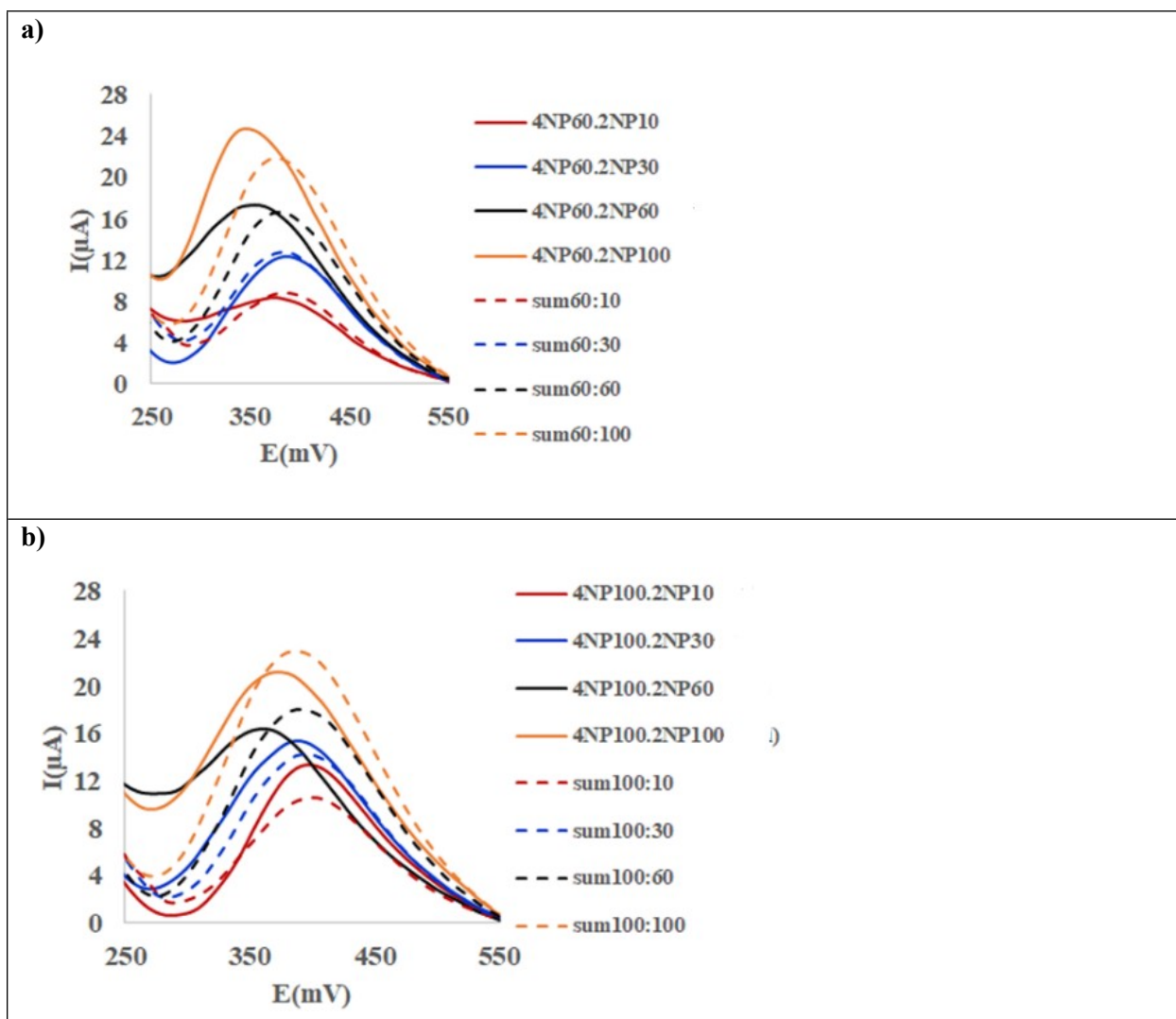


Fig. S12. SWAS voltammograms of (a): 4-NP (60ppm) in 2-NP (10-100ppm). (b): 4-NP (100ppm) in 2-NP (10-100ppm), at the Ni-MOF74/ $\text{Fe}_3\text{O}_4/\text{SiO}_2/\text{NH}_2/\beta\text{-CD}$ / GCE surface in the PBS (0.1M, pH= 9.40) at scan rate 100mVs^{-1} and duration time 50s, Pulse=500 mv.

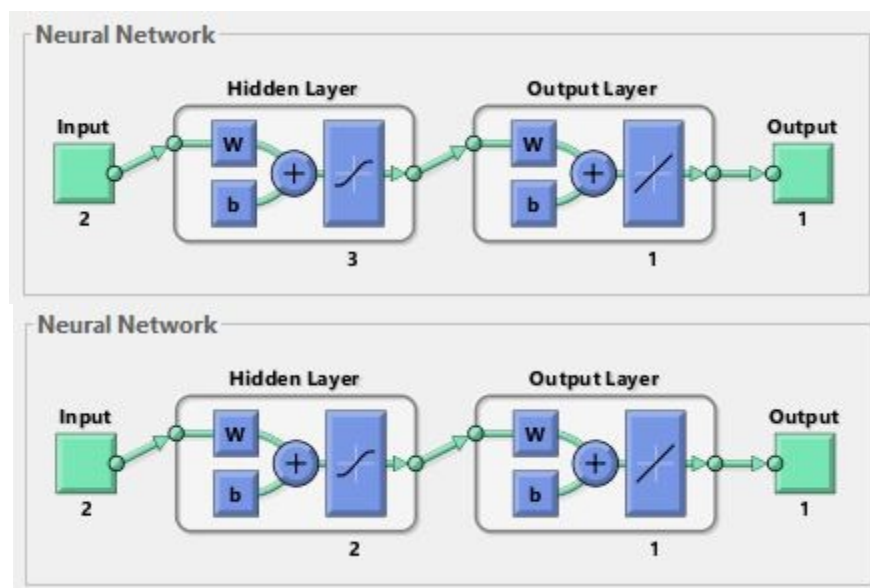


Fig.S13. the ANN's architecture for 2-NP and 4-NP

Table S1. Analysis of variance (ANOVA) result for the model of 2-NP10

Source	Sum of Squares	df	Mean Square	F-value	p-value Prob> F	
Model	0.044	2	0.022	19.84	0.0008	significant
A-A	0.038	1	0.038	34.35	0.0004	
A ²	6.146×10 ⁻³	1	6.146×10 ⁻³	5.51	0.0468	
Residual	8.920×10 ⁻³	8	1.115×10 ⁻³			
Lack of Fit	5.004×10 ⁻³	6	8.340×10 ⁻⁴	0.43	0.8234	not significant
Pure Error	3.916×10 ⁻³	2	1.958×10 ⁻³			
Cor Total	0.053	10				

Table S2. Analysis of variance (ANOVA) result for the model of 2-NP30

Source	Sum of Squares	df	Mean Square	F-value	p-value Prob> F	
Model	0.018	5	3.623×10 ⁻³	19.19	0.0028	significant
A-A	0.018	1	0.018	94.65	0.0002	
B-B	5.241×10 ⁻⁶	1	5.241×10 ⁻⁶	0.028	0.8742	
AB	1.438×10 ⁻⁴	1	1.438×10 ⁻⁴	0.76	0.4228	
A ²	4.569×10 ⁻⁶	1	4.569×10 ⁻⁶	0.024	0.8825	
B ²	9.272×10 ⁻⁵	1	9.272×10 ⁻⁵	0.49	0.5147	
Residual	9.438×10 ⁻⁴	5	1.888×10 ⁻⁴			
Lack of Fit	7.992×10 ⁻⁴	3	2.664×10 ⁻⁴	3.68	0.2209	not significant
Pure Error	1.447×10 ⁻⁴	2	7.234×10 ⁻⁵			
Cor Total	0.019	10				

Table S3. Analysis of variance (ANOVA) result for the model of 2-N100

Source	Sum of Squares	df	Mean Square	F-value		p-value Prob> F
Model	9.212×10^{-3}	5	1.842×10^{-3}	28.66	0.0011	significant
A-A	8.146×10^{-3}	1	8.146×10^{-3}	126.70	< 0.0001	
B-B	6.753×10^{-4}	1	6.753×10^{-4}	10.50	0.0229	
AB	2.196×10^{-4}	1	2.196×10^{-4}	3.42	0.1238	
A ²	1.590×10^{-4}	1	1.590×10^{-4}	2.47	0.1766	
B ²	2.459×10^{-5}	1	2.459×10^{-5}	0.38	0.5634	
Residual	3.215×10^{-4}	5	6.429×10^{-5}			
Lack of Fit	7.387×10^{-5}	3	2.462×10^{-5}	0.20	0.8898	not significant
Pure Error	2.476×10^{-4}	2	1.238×10^{-4}			
Cor Total	9.534×10^{-3}	10				

Table S4. Analysis of variance (ANOVA) result for the model of 4-NP10

Source	Sum of Squares	df	Mean Square	F-value	p-value Prob> F	
Model	6.803×10^{-3}	1	6.803×10^{-3}	9.03	0.0148	significant
A-A	6.803×10^{-3}	1	6.803×10^{-3}	9.03	0.0148	
Residual	6.777×10^{-3}	9	7.530×10^{-4}			
Lack of Fit	1.340×10^{-3}	7	1.915×10^{-4}	0.070	0.9966	not significant
Pure Error	5.437×10^{-3}	2	2.718×10^{-3}			
Cor Total	0.014	10				

Table S5. Analysis of variance (ANOVA) result for the model of 4-NP30

Source	Sum of Squares	df	Mean Square	F-value	p-value Prob> F	
Model	9.798×10^{-3}	5	1.960×10^{-3}	7.29	0.0240	significant
A-A	8.421×10^{-3}	1	8.421×10^{-3}	31.34	0.0025	
B-B	2.104×10^{-5}	1	2.104×10^{-5}	0.078	0.7908	
AB	3.956×10^{-5}	1	3.956×10^{-5}	0.15	0.7170	
A ²	4.274×10^{-4}	1	4.274×10^{-4}	1.59	0.2629	
B ²	4.839×10^{-4}	1	4.839×10^{-4}	1.80	0.2373	
Residual	1.344×10^{-3}	5	2.687×10^{-4}			
Lack of Fit	4.447×10^{-4}	3	1.482×10^{-4}	0.33	0.8096	not significant
Pure Error	8.990×10^{-4}	2	4.495×10^{-4}			
Cor Total	0.011	10				

Table S6. Analysis of variance (ANOVA) result for the model of 4-NP60

Source	Sum of Squares	df	Mean Square	F-value		p-value Prob> F
Model	4.614×10^{-3}	5	9.228×10^{-4}	9.50	0.0137	significant
A-A	4.393×10^{-3}	1	4.393×10^{-3}	45.21	0.0011	
B-B	1.727×10^{-4}	1	1.727×10^{-4}	1.78	0.2400	
AB	3.600×10^{-5}	1	3.600×10^{-5}	0.37	0.5693	
A ²	5.095×10^{-6}	1	5.095×10^{-6}	0.052	0.8280	
B ²	3.508×10^{-6}	1	3.508×10^{-6}	0.036	0.8568	
Residual	4.859×10^{-4}	5	9.717×10^{-5}			
Lack of Fit	1.235×10^{-4}	3	4.117×10^{-5}	0.23	0.8718	not significant
Pure Error	3.624×10^{-4}	2	1.812×10^{-4}			
Cor Total	5.100×10^{-3}	10				

Table S7. Analysis of variance (ANOVA) result for the model of 4-N100

Source	Sum of Squares	df	Mean Square	F-value	p-value Prob> F
Model	3.046×10^{-3}	5	6.093×10^{-4}	6.80	0.0277 significant
A-A	2.517×10^{-3}	1	2.517×10^{-3}	28.10	0.0032
B-B	1.726×10^{-4}	1	1.726×10^{-4}	1.93	0.2237
AB	4.851×10^{-5}	1	4.851×10^{-5}	0.54	0.4948
A ²	7.720×10^{-5}	1	7.720×10^{-5}	0.86	0.3958
B ²	2.881×10^{-4}	1	2.881×10^{-4}	3.22	0.1329
Residual	4.479×10^{-4}	5	8.957×10^{-5}		
Lack of Fit	2.044×10^{-4}	3	6.815×10^{-5}	0.56	0.6916 not significant
Pure Error	2.434×10^{-4}	2	1.217×10^{-4}		
Cor Total	3.494×10^{-3}	10			

Table S8. The network parameters in the MATLAB toolbox.

Topology	2 inputs, 1 output and 1 hidden layer with 2 neurons 2-NP: ($2 \times 2 \times 1$), 3 neurons 4-NP ($2 \times 3 \times 1$),
Data	Training set: 24 randomly selected data structures Test set: 3 randomly selected data structures Validation set: 3 randomly selected data structures
Beginning function	Log-sigmoid
Training algorithm	Levenberge–Marquardt
Loss function conditions	Minimum MSE
Stopping conditions	The network stops in one of three way: Validation check > 10 Minimum gradient $< 10^{-7}$ Momentum speed $> 10^{10}$

