

Radial Basis Function Network Learns Three Functions by James Pate Williams, Jr., BA, BS, MSWE, PhD

The three functions to be learned are:

$$f(x, y, z) = x^2 + y^2 + z^2$$

$$g(x, y, z) = x^2 + y^2 + z^3$$

$$h(x, y, z) = x \sin x + y^2 + z^3$$

The output consists of the independent variables, the dependent variable, and the learned dependent variable. We only show the Mean Average Deviation of the training Set, the Mean Square Error of the Training Set, and the Mean Average Deviation of the Test Set, the Mean Square Error of the Test Set. The parameters are the Gaussian function sigma variables and the pseudorandom generator seed.

RBFNThreeFunctions

File Help

Sigma: 0.1

Seed: 1

Options

☒ f1[x, y, z] = $x^2 + y^2 + z^2$

☐ f2[x, y, z] = $x^2 + y^2 + z^3$

☐ f3[x, y, z] = $x * \sin[x] + y^2 + z^3$

Compute

Clear

0.97842	-0.05365	0.63747	1.36656	0.68304
0.82604	0.63427	-0.98349	2.05189	1.79992
-0.10251	-0.75582	0.45640	0.79008	0.78679
-0.28980	0.29038	0.71236	0.67577	0.32886
0.44575	-0.74554	0.20463	0.79639	0.79627
0.88934	0.18293	0.20301	0.86560	0.82034
0.54448	-0.06137	-0.12775	0.31655	0.28737
0.41053	0.22163	-0.16645	0.24536	0.17247
-0.12857	-0.73330	0.64333	0.96813	0.96574
-0.11219	-0.82122	0.10868	0.69880	0.69794
0.21128	-0.59111	0.61827	0.77632	0.25745
0.37819	-0.77252	0.17057	0.76890	0.76276
0.30399	-0.19816	-0.77117	0.72639	0.40550
-0.49486	-0.23850	0.09275	0.31037	0.24533
0.75607	0.90991	-0.19962	1.43942	1.43147

Mean Avg Dev Train : 1.54215591e-01

Mean Square Error Train: 2.60824612e-01

Mean Avg Dev Test : 1.47205348e-01

Mean Square Error Test : 2.54433458e-01

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☒ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.36656	1.32578
0.82604	0.63427	-0.98349	2.05189	2.05040
-0.10251	-0.75582	0.45640	0.79008	0.79008
-0.28980	0.29038	0.71236	0.67577	0.53802
0.44575	-0.74554	0.20463	0.79639	0.79639
0.88934	0.18293	0.20301	0.86560	0.86560
0.54448	-0.06137	-0.12775	0.31655	0.31653
0.41053	0.22163	-0.16645	0.24536	0.24510
-0.12857	-0.73330	0.64333	0.96813	0.96813
-0.11219	-0.82122	0.10868	0.69880	0.69880
0.21128	-0.59111	0.61827	0.77632	0.56359
0.37819	-0.77252	0.17057	0.76890	0.76890
0.30399	-0.19816	-0.77117	0.72639	0.71178
-0.49486	-0.23850	0.09275	0.31037	0.30897
0.75607	0.90991	-0.19962	1.43942	1.43942

Mean Avg Dev Train : 2.74595847e-02
 Mean Square Error Train: 7.02647009e-02
 Mean Avg Dev Test : 2.55644808e-02
 Mean Square Error Test : 6.42785726e-02

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☒ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.36656	1.36656
0.82604	0.63427	-0.98349	2.05189	2.05189
-0.10251	-0.75582	0.45640	0.79008	0.79008
-0.28980	0.29038	0.71236	0.67577	0.67192
0.44575	-0.74554	0.20463	0.79639	0.79639
0.88934	0.18293	0.20301	0.86560	0.86560
0.54448	-0.06137	-0.12775	0.31655	0.31655
0.41053	0.22163	-0.16645	0.24536	0.24536
-0.12857	-0.73330	0.64333	0.96813	0.96813
-0.11219	-0.82122	0.10868	0.69880	0.69880
0.21128	-0.59111	0.61827	0.77632	0.77187
0.37819	-0.77252	0.17057	0.76890	0.76890
0.30399	-0.19816	-0.77117	0.72639	0.72639
-0.49486	-0.23850	0.09275	0.31037	0.31037
0.75607	0.90991	-0.19962	1.43942	1.43942

Mean Avg Dev Train : 1.91283349e-04
 Mean Square Error Train: 6.35845693e-04
 Mean Avg Dev Test : 5.18410365e-04
 Mean Square Error Test : 1.46992031e-03

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☒ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.36656	1.36656
0.82604	0.63427	-0.98349	2.05189	2.05189
-0.10251	-0.75582	0.45640	0.79008	0.79008
-0.28980	0.29038	0.71236	0.67577	0.67577
0.44575	-0.74554	0.20463	0.79639	0.79639
0.88934	0.18293	0.20301	0.86560	0.86560
0.54448	-0.06137	-0.12775	0.31655	0.31655
0.41053	0.22163	-0.16645	0.24536	0.24536
-0.12857	-0.73330	0.64333	0.96813	0.96813
-0.11219	-0.82122	0.10868	0.69880	0.69880
0.21128	-0.59111	0.61827	0.77632	0.77632
0.37819	-0.77252	0.17057	0.76890	0.76890
0.30399	-0.19816	-0.77117	0.72639	0.72639
-0.49486	-0.23850	0.09275	0.31037	0.31037
0.75607	0.90991	-0.19962	1.43942	1.43942

Mean Avg Dev Train : 2.85078362e-09
 Mean Square Error Train: 1.07650274e-08
 Mean Avg Dev Test : 5.36837143e-08
 Mean Square Error Test : 1.52204049e-07

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☒ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.36656	1.36656
0.82604	0.63427	-0.98349	2.05189	2.05189
-0.10251	-0.75582	0.45640	0.79008	0.79008
-0.28980	0.29038	0.71236	0.67577	0.67577
0.44575	-0.74554	0.20463	0.79639	0.79639
0.88934	0.18293	0.20301	0.86560	0.86560
0.54448	-0.06137	-0.12775	0.31655	0.31655
0.41053	0.22163	-0.16645	0.24536	0.24536
-0.12857	-0.73330	0.64333	0.96813	0.96813
-0.11219	-0.82122	0.10868	0.69880	0.69880
0.21128	-0.59111	0.61827	0.77632	0.77632
0.37819	-0.77252	0.17057	0.76890	0.76890
0.30399	-0.19816	-0.77117	0.72639	0.72639
-0.49486	-0.23850	0.09275	0.31037	0.31037
0.75607	0.90991	-0.19962	1.43942	1.43942

Mean Avg Dev Train : 0.00000000e+00
 Mean Square Error Train: 0.00000000e+00
 Mean Avg Dev Test : 8.81239526e-16
 Mean Square Error Test : 2.49877267e-15

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RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☐ f1[x, y, z] = x² + y² + z²

☒ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

```

0.97842 -0.05365 0.63747 1.21924 0.60954
0.82604 0.63427 -0.98349 0.13336 0.11698
-0.10251 -0.75582 0.45640 0.67685 0.67403
-0.28980 0.29038 0.71236 0.52981 0.25783
0.44575 -0.74554 0.20463 0.76309 0.76297
0.88934 0.18293 0.20301 0.83275 0.78921
0.54448 -0.06137 -0.12775 0.29814 0.27066
0.41053 0.22163 -0.16645 0.21305 0.14975
-0.12857 -0.73330 0.64333 0.82052 0.81849
-0.11219 -0.82122 0.10868 0.68828 0.68729
0.21128 -0.59111 0.61827 0.63040 0.20906
0.37819 -0.77252 0.17057 0.74477 0.73882
0.30399 -0.19816 -0.77117 -0.32694 -0.18251
-0.49486 -0.23850 0.09275 0.30257 0.23916
0.75607 0.90991 -0.19962 1.39162 1.38393

Mean Avg Dev Train      : 9.92251428e-02
Mean Square Error Train: 1.78894184e-01
Mean Avg Dev Test       : 1.05070141e-01
Mean Square Error Test  : 2.02351995e-01

```

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☐ f1[x, y, z] = x² + y² + z²

☒ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

```

0.97842 -0.05365 0.63747 1.21924 1.18286
0.82604 0.63427 -0.98349 0.13336 0.13326
-0.10251 -0.75582 0.45640 0.67685 0.67685
-0.28980 0.29038 0.71236 0.52981 0.42181
0.44575 -0.74554 0.20463 0.76309 0.76309
0.88934 0.18293 0.20301 0.83275 0.83275
0.54448 -0.06137 -0.12775 0.29814 0.29813
0.41053 0.22163 -0.16645 0.21305 0.21281
-0.12857 -0.73330 0.64333 0.82052 0.82052
-0.11219 -0.82122 0.10868 0.68828 0.68828
0.21128 -0.59111 0.61827 0.63040 0.45766
0.37819 -0.77252 0.17057 0.74477 0.74477
0.30399 -0.19816 -0.77117 -0.32694 -0.32037
-0.49486 -0.23850 0.09275 0.30257 0.30120
0.75607 0.90991 -0.19962 1.39162 1.39162

Mean Avg Dev Train      : 1.98602414e-02
Mean Square Error Train: 5.35820466e-02
Mean Avg Dev Test       : 2.03375432e-02
Mean Square Error Test  : 5.17635839e-02

```

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☐ f1[x, y, z] = x² + y² + z²

☒ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.21924	1.21924
0.82604	0.63427	-0.98349	0.13336	0.13336
-0.10251	-0.75582	0.45640	0.67685	0.67685
-0.28980	0.29038	0.71236	0.52981	0.52679
0.44575	-0.74554	0.20463	0.76309	0.76309
0.88934	0.18293	0.20301	0.83275	0.83275
0.54448	-0.06137	-0.12775	0.29814	0.29814
0.41053	0.22163	-0.16645	0.21305	0.21305
-0.12857	-0.73330	0.64333	0.82052	0.82052
-0.11219	-0.82122	0.10868	0.68828	0.68828
0.21128	-0.59111	0.61827	0.63040	0.62679
0.37819	-0.77252	0.17057	0.74477	0.74477
0.30399	-0.19816	-0.77117	-0.32694	-0.32694
-0.49486	-0.23850	0.09275	0.30257	0.30257
0.75607	0.90991	-0.19962	1.39162	1.39162

Mean Avg Dev Train : 1.30547640e-04
Mean Square Error Train: 4.49513017e-04
Mean Avg Dev Test : 4.14229415e-04
Mean Square Error Test : 1.17615717e-03

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☐ f1[x, y, z] = x² + y² + z²

☒ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.21924	1.21924
0.82604	0.63427	-0.98349	0.13336	0.13336
-0.10251	-0.75582	0.45640	0.67685	0.67685
-0.28980	0.29038	0.71236	0.52981	0.52981
0.44575	-0.74554	0.20463	0.76309	0.76309
0.88934	0.18293	0.20301	0.83275	0.83275
0.54448	-0.06137	-0.12775	0.29814	0.29814
0.41053	0.22163	-0.16645	0.21305	0.21305
-0.12857	-0.73330	0.64333	0.82052	0.82052
-0.11219	-0.82122	0.10868	0.68828	0.68828
0.21128	-0.59111	0.61827	0.63040	0.63040
0.37819	-0.77252	0.17057	0.74477	0.74477
0.30399	-0.19816	-0.77117	-0.32694	-0.32694
-0.49486	-0.23850	0.09275	0.30257	0.30257
0.75607	0.90991	-0.19962	1.39162	1.39162

Mean Avg Dev Train : 1.72148484e-09
Mean Square Error Train: 6.53038444e-09
Mean Avg Dev Test : 4.28927426e-08
Mean Square Error Test : 1.21774138e-07

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☐ f1[x, y, z] = x² + y² + z²

☒ f2[x, y, z] = x² + y² + z³

☐ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.21924	1.21924
0.82604	0.63427	-0.98349	0.13336	0.13336
-0.10251	-0.75582	0.45640	0.67685	0.67685
-0.28980	0.29038	0.71236	0.52981	0.52981
0.44575	-0.74554	0.20463	0.76309	0.76309
0.88934	0.18293	0.20301	0.83275	0.83275
0.54448	-0.06137	-0.12775	0.29814	0.29814
0.41053	0.22163	-0.16645	0.21305	0.21305
-0.12857	-0.73330	0.64333	0.82052	0.82052
-0.11219	-0.82122	0.10868	0.68828	0.68828
0.21128	-0.59111	0.61827	0.63040	0.63040
0.37819	-0.77252	0.17057	0.74477	0.74477
0.30399	-0.19816	-0.77117	-0.32694	-0.32694
-0.49486	-0.23850	0.09275	0.30257	0.30257
0.75607	0.90991	-0.19962	1.39162	1.39162

Mean Avg Dev Train : 0.00000000e+00
 Mean Square Error Train: 0.00000000e+00
 Mean Avg Dev Test : 7.00828284e-16
 Mean Square Error Test : 1.99009606e-15

RBFNThreeFunctions

File Help

Sigma:

Seed:

Options

☐ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☒ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.07364	0.53692
0.82604	0.63427	-0.98349	0.05837	0.05120
-0.10251	-0.75582	0.45640	0.67683	0.67401
-0.28980	0.29038	0.71236	0.52863	0.25726
0.44575	-0.74554	0.20463	0.75657	0.75646
0.88934	0.18293	0.20301	0.73254	0.69423
0.54448	-0.06137	-0.12775	0.28371	0.25756
0.41053	0.22163	-0.16645	0.20835	0.14645
-0.12857	-0.73330	0.64333	0.82047	0.81845
-0.11219	-0.82122	0.10868	0.68825	0.68711
0.21128	-0.59111	0.61827	0.63007	0.20895
0.37819	-0.77252	0.17057	0.74138	0.73547
0.30399	-0.19816	-0.77117	-0.32836	-0.18331
-0.49486	-0.23850	0.09275	0.29269	0.23135
0.75607	0.90991	-0.19962	1.33869	1.33130

Mean Avg Dev Train : 9.25025199e-02
 Mean Square Error Train: 1.64762625e-01
 Mean Avg Dev Test : 9.92834459e-02
 Mean Square Error Test : 1.88744855e-01

RBFNThreeFunctions

File Help

Sigma: 0.05

Seed: 1

Options

☐ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☒ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.07364	1.04161
0.82604	0.63427	-0.98349	0.05837	0.05832
-0.10251	-0.75582	0.45640	0.67683	0.67683
-0.28980	0.29038	0.71236	0.52863	0.42088
0.44575	-0.74554	0.20463	0.75657	0.75657
0.88934	0.18293	0.20301	0.73254	0.73254
0.54448	-0.06137	-0.12775	0.28371	0.28369
0.41053	0.22163	-0.16645	0.20835	0.20813
-0.12857	-0.73330	0.64333	0.82047	0.82047
-0.11219	-0.82122	0.10868	0.68825	0.68825
0.21128	-0.59111	0.61827	0.63007	0.45741
0.37819	-0.77252	0.17057	0.74138	0.74138
0.30399	-0.19816	-0.77117	-0.32836	-0.32176
-0.49486	-0.23850	0.09275	0.29269	0.29137
0.75607	0.90991	-0.19962	1.33869	1.33869

Mean Avg Dev Train : 1.85642960e-02
 Mean Square Error Train: 4.99772855e-02
 Mean Avg Dev Test : 2.00406439e-02
 Mean Square Error Test : 5.15337586e-02

RBFNThreeFunctions

File Help

Sigma: 0.025

Seed: 1

Options

☐ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☒ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.07364	1.07364
0.82604	0.63427	-0.98349	0.05837	0.05837
-0.10251	-0.75582	0.45640	0.67683	0.67683
-0.28980	0.29038	0.71236	0.52863	0.52562
0.44575	-0.74554	0.20463	0.75657	0.75657
0.88934	0.18293	0.20301	0.73254	0.73254
0.54448	-0.06137	-0.12775	0.28371	0.28371
0.41053	0.22163	-0.16645	0.20835	0.20835
-0.12857	-0.73330	0.64333	0.82047	0.82047
-0.11219	-0.82122	0.10868	0.68825	0.68825
0.21128	-0.59111	0.61827	0.63007	0.62646
0.37819	-0.77252	0.17057	0.74138	0.74138
0.30399	-0.19816	-0.77117	-0.32836	-0.32836
-0.49486	-0.23850	0.09275	0.29269	0.29269
0.75607	0.90991	-0.19962	1.33869	1.33869

Mean Avg Dev Train : 1.21436882e-04
 Mean Square Error Train: 4.16495818e-04
 Mean Avg Dev Test : 4.13688131e-04
 Mean Square Error Test : 1.17472496e-03

RBFNThreeFunctions

File Help

Sigma: 0.015

Seed: 1

Options

☐ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☒ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.07364	1.07364
0.82604	0.63427	-0.98349	0.05837	0.05837
-0.10251	-0.75582	0.45640	0.67683	0.67683
-0.28980	0.29038	0.71236	0.52863	0.52863
0.44575	-0.74554	0.20463	0.75657	0.75657
0.88934	0.18293	0.20301	0.73254	0.73254
0.54448	-0.06137	-0.12775	0.28371	0.28371
0.41053	0.22163	-0.16645	0.20835	0.20835
-0.12857	-0.73330	0.64333	0.82047	0.82047
-0.11219	-0.82122	0.10868	0.68825	0.68825
0.21128	-0.59111	0.61827	0.63007	0.63007
0.37819	-0.77252	0.17057	0.74138	0.74138
0.30399	-0.19816	-0.77117	-0.32836	-0.32836
-0.49486	-0.23850	0.09275	0.29269	0.29269
0.75607	0.90991	-0.19962	1.33869	1.33869

Mean Avg Dev Train : 1.58130957e-09
 Mean Square Error Train: 5.90384515e-09
 Mean Avg Dev Test : 4.28372116e-08
 Mean Square Error Test : 1.21625283e-07

RBFNThreeFunctions

File Help

Sigma: 0.01

Seed: 1

Options

☐ f1[x, y, z] = x² + y² + z²

☐ f2[x, y, z] = x² + y² + z³

☒ f3[x, y, z] = x * sin[x] + y² + z³

Compute

Clear

0.97842	-0.05365	0.63747	1.07364	1.07364
0.82604	0.63427	-0.98349	0.05837	0.05837
-0.10251	-0.75582	0.45640	0.67683	0.67683
-0.28980	0.29038	0.71236	0.52863	0.52863
0.44575	-0.74554	0.20463	0.75657	0.75657
0.88934	0.18293	0.20301	0.73254	0.73254
0.54448	-0.06137	-0.12775	0.28371	0.28371
0.41053	0.22163	-0.16645	0.20835	0.20835
-0.12857	-0.73330	0.64333	0.82047	0.82047
-0.11219	-0.82122	0.10868	0.68825	0.68825
0.21128	-0.59111	0.61827	0.63007	0.63007
0.37819	-0.77252	0.17057	0.74138	0.74138
0.30399	-0.19816	-0.77117	-0.32836	-0.32836
-0.49486	-0.23850	0.09275	0.29269	0.29269
0.75607	0.90991	-0.19962	1.33869	1.33869

Mean Avg Dev Train : 0.00000000e+00
 Mean Square Error Train: 0.00000000e+00
 Mean Avg Dev Test : 7.00828284e-16
 Mean Square Error Test : 1.99009606e-15