

# Train RBF networks using a method of three phases

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## Abstract

Radial Basis Function (RBF) networks are well established machine learning tools used in a variety of classification and regression problems. A key component of these networks is their radial functions. These networks acquire adaptive capabilities through a two-stage training technique in most cases. In the first stage, the centers and variances for the radial functions are estimated, and in the second stage, through the solution of a linear system, the external weights for the radial functions are adjusted. However, in many cases this training technique has reduced performance either due to instability in arithmetic operations or due to trapping in local minima of the training error. In this paper, a three-stage method is proposed to address the above problems. In the first stage, an initial estimate of the intervals for the network parameter values is made, in the second stage, the network parameter values are adjusted within the intervals of the first phase, and finally in the third stage of the proposed technique, a local optimization method is used for the final adjustment of the network parameters. The proposed method was tested for its efficiency on a wide series of regression and classification datasets from the related bibliography with exceptional results.

**Keywords:** Machine learning; Neural networks; Genetic algorithms; Optimization

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**Abbreviations**

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	Linear dichroism

**Appendix A**

*Appendix A.1*

The appendix is an optional section that can contain details and data supplemental to the main text—for example, explanations of experimental details that would disrupt the

flow of the main text but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data are shown in the main text can be added here if brief, or as Supplementary Data. Mathematical proofs of results not central to the paper can be added as an appendix.

**Table A1.** This is a table caption.

Title 1	Title 2	Title 3
Entry 1	Data	Data
Entry 2	Data	Data

**Appendix B**

All appendix sections must be cited in the main text. In the appendices, Figures, Tables, etc. should be labeled, starting with “A”—e.g., Figure A1, Figure A2, etc.

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Author 1, T. The title of the cited article. *Journal Abbreviation* **2008**, *10*, 142–149.

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Author 2, L. The title of the cited contribution. In *The Book Title*; Editor1, F., Editor2, A., Eds.; Publishing House: City, Country, 2007; pp. 32–58.

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