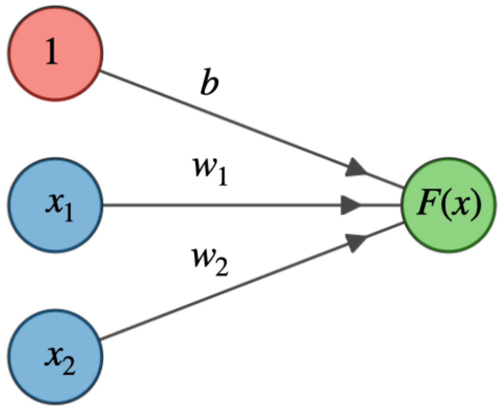
# SNN Example 15 - Linear Models

The major reason for the popularity of neural networks is their ability to model nonlinear problems; i.e., classification problems that cannot be solved simply by drawing a single hyperplane between classes, and regression problems that cannot be solved simply by drawing a hyperplane through the data.
Despite this, linear models should not be neglected. It is not too uncommon to find that a problem that was perceived to be difficult and nonlinear can actually be solved adequately by linear techniques, and a linear model always provides a good benchmark against which to judge more complex techniques.

*STATISTICA Neural Networks* builds linear models using a special linear network type. A linear network has only two layers: an input layer, and an output layer with linear SynapticP and activation functions. See also, Synaptic Functions and Activation Functions.

Linear networks, like the output layer of an RBF network, can be optimized directly using the pseudo-inverse technique. They are designed principally for regression problems, but are equally able to perform a simple discriminant analysis on classification problems. See also, Linear Networks and Radial Basis Function Networks.

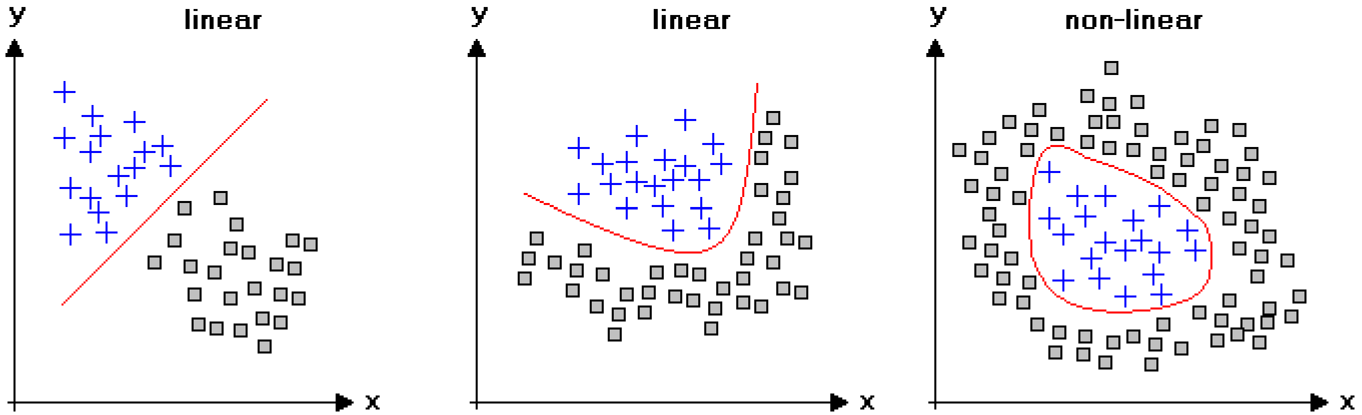
**Linear regression**




$$F(x) = w^T x + b$$

Input Layer $\in \mathbb{R}^3$ Output Layer $\in \mathbb{R}^1$

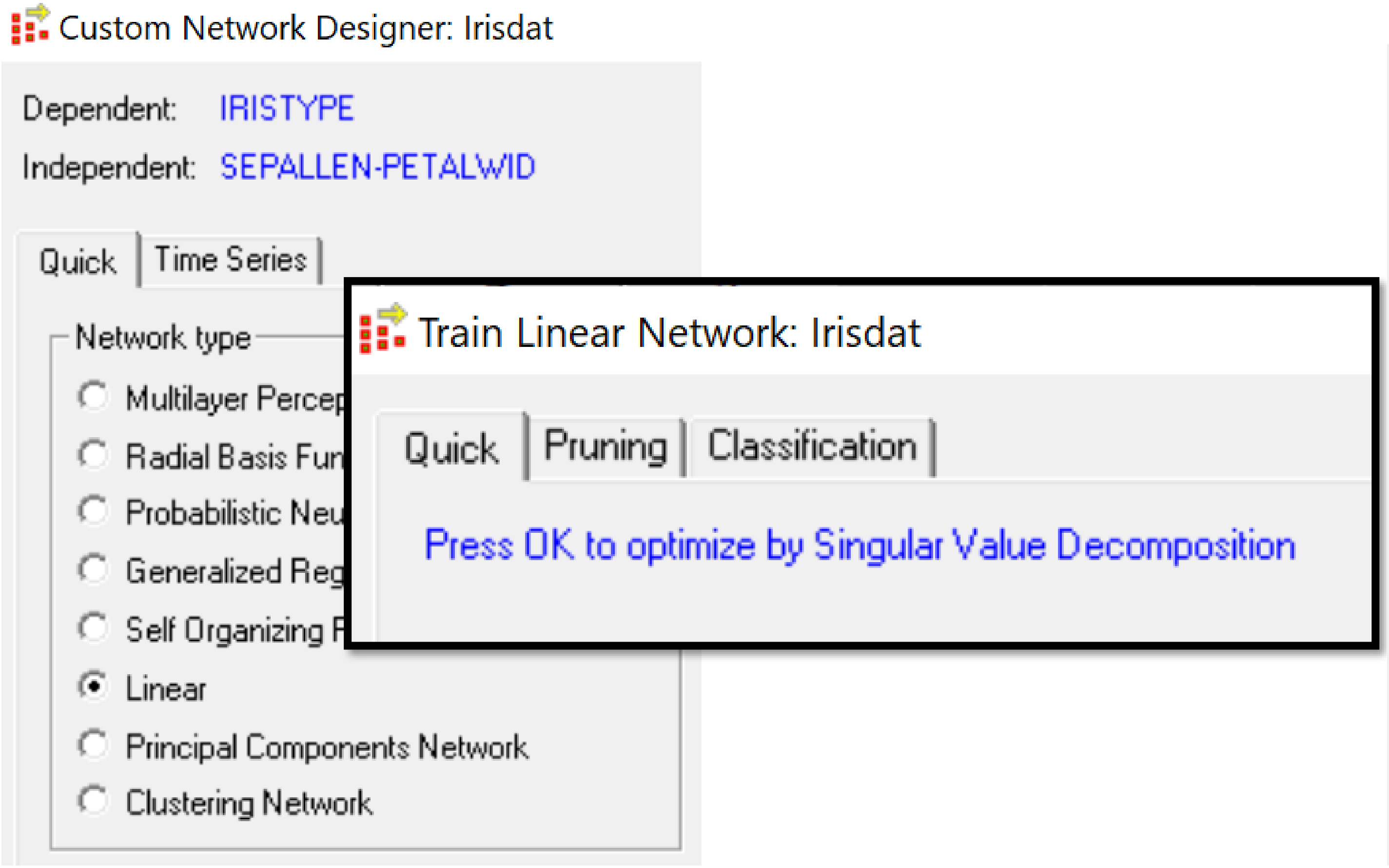
$$F(x) = w_1 \cdot x_1 + w_2 \cdot x_2 + 1 \cdot b$$

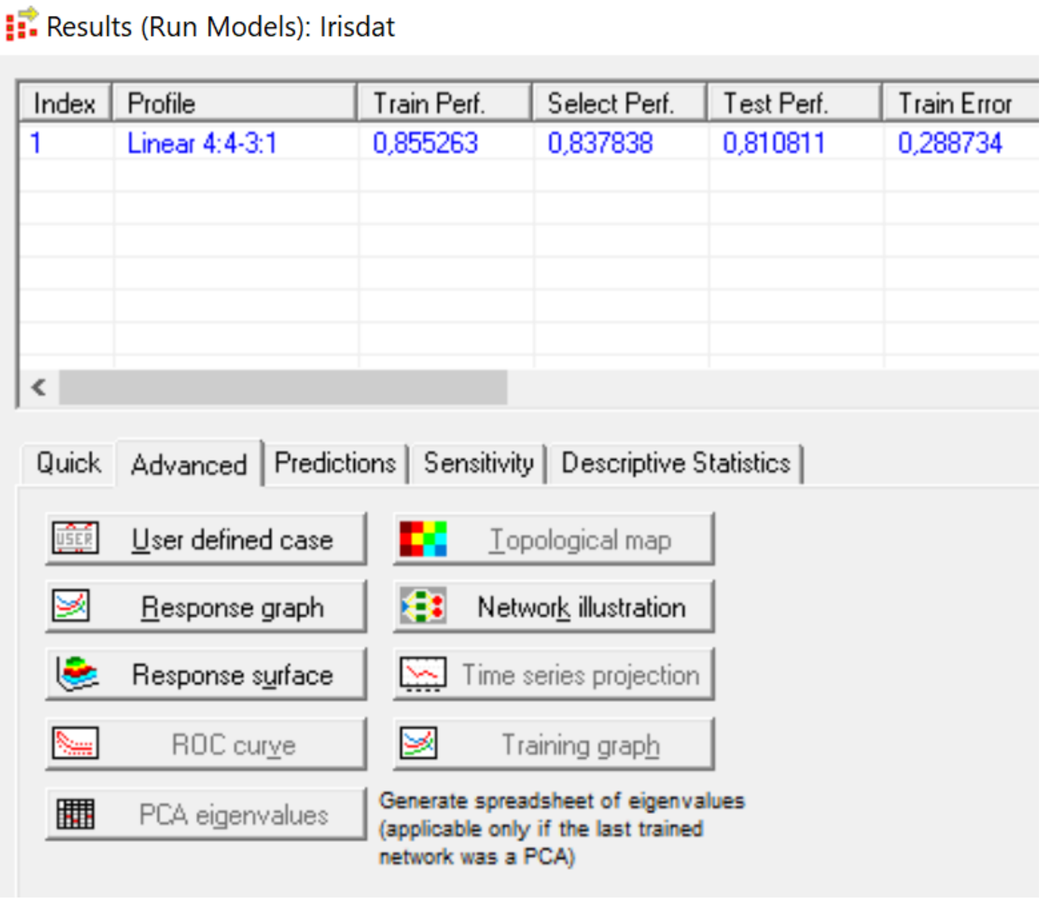


To create a linear model of the Iris regression problem, use the *Custom Network Designer* dialog as usual, setting the *Network type* option to *Linear*. Linear networks do not have hidden units, so there are no further settings to make.

Training a Linear network is equally straightforward - just press the *OK* button on the *Train Linear Network* dialog.

Linear models are actually ill-suited to the Iris problem, as the *VERSICOL* and *VIRGINIC* species are not linearly separable, and if you generate *Descriptive statistics* you will see a significant amount of misclassification between these two classes.



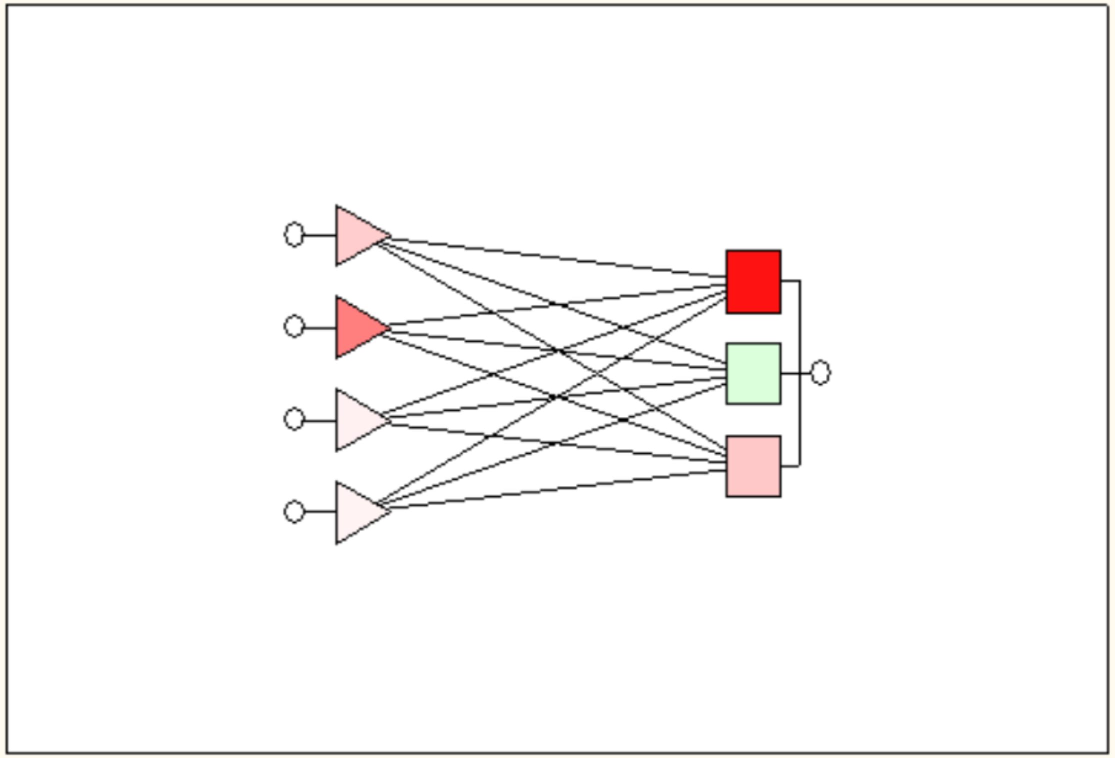



| Index | Model Summary Report (Irisdat) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Profile** | Train Perf. | Select Perf. | Test Perf. | Train Error | Select Error | Test Error | Training/Members | Note | Inputs | Hidden(1) | Hidden(2) |
| **1** | Linear 4:4-3:1 | 0,855263 | 0,837838 | 0,810811 | 0,288734 | 0,301891 | 0,322531 | PI | | 4 | 0 | 0 |

| | Confusion Matrix - IRISTYPE(1) (Irisdat) | | |
|---|---|---|---|
| | SETOSA | VIRGINIC | VERSICOL |
| SETOSA.1 | 50,00000 | 0,00000 | 0,00000 |
| VIRGINIC.1 | 0,00000 | 42,00000 | 16,00000 |
| VERSICOL.1 | 0,00000 | 8,00000 | 34,00000 |

| | Classification (1 ) (Irisdat) | | |
|---|---|---|---|
| | IRISTYPE.SETOSA.1 | IRISTYPE.VIRGINIC.1 | IRISTYPE.VERSICOL.1 |
| Total | 50,0000 | 50,00000 | 50,00000 |
| Correct | 50,0000 | 42,00000 | 34,00000 |
| Wrong | 0,0000 | 8,00000 | 16,00000 |
| Unknown | 0,0000 | 0,00000 | 0,00000 |
| Correct(%) | 100,0000 | 84,00000 | 68,00000 |
| Wrong(%) | 0,0000 | 16,00000 | 32,00000 |
| Unknown(%) | 0,0000 | 0,00000 | 0,00000 |

Profile : Linear 4:4-3:1 , Index = 1
Train Perf. = 0,842105 , Select Perf. = 0,864865 , Test Perf. = 0,837838



| | Sensitivity Analysis - 1 (Irisdat) | | | |
|---|---|---|---|---|
| | **SEPALLEN** | SEPALWID | PETALLEN | PETALWID |
| **Ratio.1** | 1,040763 | 1,056140 | 1,860177 | 1,719268 |
| Rank.1 | 4,000000 | 3,000000 | 1,000000 | 2,000000 |