Let the input vectors be $\{p_i;\ i = 1, 2, ..., P\}$. P is the total number of input patterns. Let the output vectors of the MLP be $\{y^{(p_i)};\ i = 1, 2, ..., P\}$. Let N be the dimension of the input vector, p_i, and M be the dimension of the output vector, $y^{(p_i)}$, of the MLP. The total number of neurons in the input layer of the MPL is N. The total number of neurons in the output layer of the MLP is M. Let P be the total number of input patterns. Let L be the total number of hidden layers in the MLP. This MLP has $L + 1$ layers. We apply BP to train the MLP with different energies.

Type I: SIR-SOM

In this type $N >> 2$, $M = 2$, and L is an arbitrary number. This type provides a 2D manifold or a dimension reduction from N to $M = 2$. The object energy can be set as E^{rep} in (1) or E^{att} in (2). There are many other options for the energy.

(i) The object distance between two output vectors, $d(y^{(p_i)}, y^{(p_j)})$, can be set as the distance between the input vectors, that is $d(y^{(p_i)}, y^{(p_j)}) = d(p_i, p_j)$ or $d(y^{(p_i)}, y^{(p_j)}) \sim d(p_i, p_j)$. $d(.)$ may be set as the Eucliden distance.

(ii) The object distance between two output vectors, $d(y^{(p_i)}, y^{(p_j)})$, is set as the repellence force as that in E^{rep} when the input patterns p_i and p_j are in two ifferent classes and as the attraction force as that in E^{att} when the input patterns p_i and p_j in the same class.

(iii) The energy E^{rep} and E^{att} may include only those neighborhood patterns, that is

$$E^{rep} = -\frac{1}{2} \sum^{P} \sum_{\{p_j \ neighbor \ with \ p_i\}}^{P} (d(y^{(p_i)}, y^{(p_j)}))^2.$$

The energy counts only neighborhood input patterns.

Type II: SIR-kernel

In this type $M >> N$, $M >> 1$, and L is an arbitrary number. The object energy is set as E^{rep} in (1). There are other options for the energy.

(i) The object distance in E^{rep} between two output vectors, $d(y^{(p_i)}, y^{(p_j)})$, can be set as the Eucliden distance.

(ii) The object distance between two output vectors, $d(y^{(p_i)}, y^{(p_j)})$, is set as the repellence force as that in E^{rep} when the input patterns p_i and p_j are in two different classes and as the attraction force as that in E^{att} when the input patterns p_i and p_j in the same class.

Type III: SIR-recurrent

In this type $M = N$ and L is arbitrary. One restoration example plus it code is shown in Section 3 in Chapter 5.

Type IV: SIR-Hopfield

In this type $M = N$ and there is no hidden layer in between the input layer and the output layer, that is $L = 0$. The energy is

$E^{Hopfield} = -\frac{1}{2} \sum_{\{p_i'\}}^{P} (d(y^{(p_i)}, p_i'))^2$ where p_i' is a noisy pattern of p_i. Both noisy patterns and correct patterns are used in the training. The noisy patterns may be generated artificially or provided otherwise.

Type V: SIR-module

In this type $M = N$ and L is arbitrary. The MLP serves as the transformation. One may use any objection energy to manipulate the transformation freely.