A unit may belong to several layers at the same time. The assignment of units to layers can be done with the menu `assign layers` invoked with the button `OPTIONS` in the main Info panel.

4. `COLOR` sets the 2D–display colors. On monochrome terminals, black on white or white on black representation of the network can be selected from a popup menu. On color displays, a color editing window is opened. This window consists of three parts: The palette of available colors at the top, the buttons to select the item to be colored in the lower left region, and the color preview window in the lower right region.

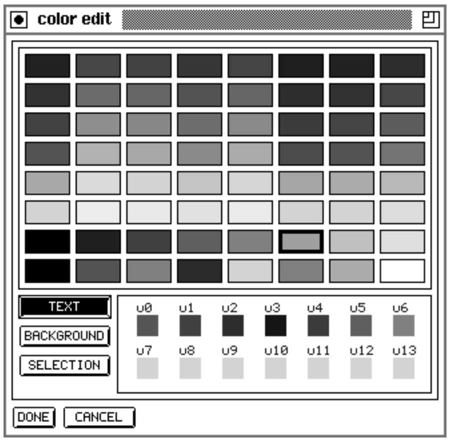

Figure 4.15: Color Setup Panel.

A color is set by clicking first at the appropriate button (`TEXT`, `BACKGROUND`, or `SELECTION`) and then at the desired color in the color palette. The selected setting is immediately displayed in the color preview window. All colors may be set in any order and any number of times. The changes become effective in the corresponding 2D–display only after both the setup panel and the color edit panel have been dismissed with the `DONE` button.

5. Sliders for the selection of link display parameters, `links positive` and `links negative`:

There are two slidebars to set thresholds for the display of links. When the bubble is moved, the current threshold is displayed in absolute and relative value at the bottom of the setup panel. Only those links with an absolute value above the threshold are displayed. The range of the absolute values is $0.0 \leq linkTrigger \leq 10.0$ (see also paragraph 4.3.5). The trigger values can be set independently for positive and negative weights. With these link thresholds the user can concentrate on the strong connections. Reducing the number of links drawn is an effective means to speed up the drawing of the displays, since line drawing takes most of the time to display a network.

Note: The links that are not drawn are only invisible. They still remain accessible, i.e. they are affected by editor operations.

6. `units scale`: This slidebar sets the parameter *scaleFactor* for the size of the growing boxes of the units. Its range is $0.0 \leq scaleFaktor \leq 2.0$. A scale factor of 0.5 draws the unit with activation 0.5 with full size. A scale factor of 2.0 draws a unit with activation 1.0 only with half size.

7. `grid width`: This value sets the width of the grid on which the units are placed. For some nets, changing the default of 37 pixels may be useful, e.g. to be able to better position the units in a geometrical pattern. Overlapping tops and bottoms occur if a grid size of less than 35 pixels is selected (26 pixels if units are displayed without numerical values). This overlap, however, does not affect computation in any way.

8. `origin (grid)`: These two fields determine the origin of the window, i.e. the grid position of the top left corner. There, the left field represents the x coordinate, the right is the y coordinate. The origin is usually (0, 0). Setting it to (20, 0) moves the display 20 units to the right and 10 units down in the grid.

9. `subnet number`: This field adjusts the subnet number to be displayed in this window. Values between -32736 and $+32735$ are possible here.

4.3.6 Graph Window

Graph is a tool to visualize the error development of a net. The program is started by clicking the `graph` button in the manager panel or by typing Alt-g in any SNNS window. Figure 4.16 shows the window of the graph tool.

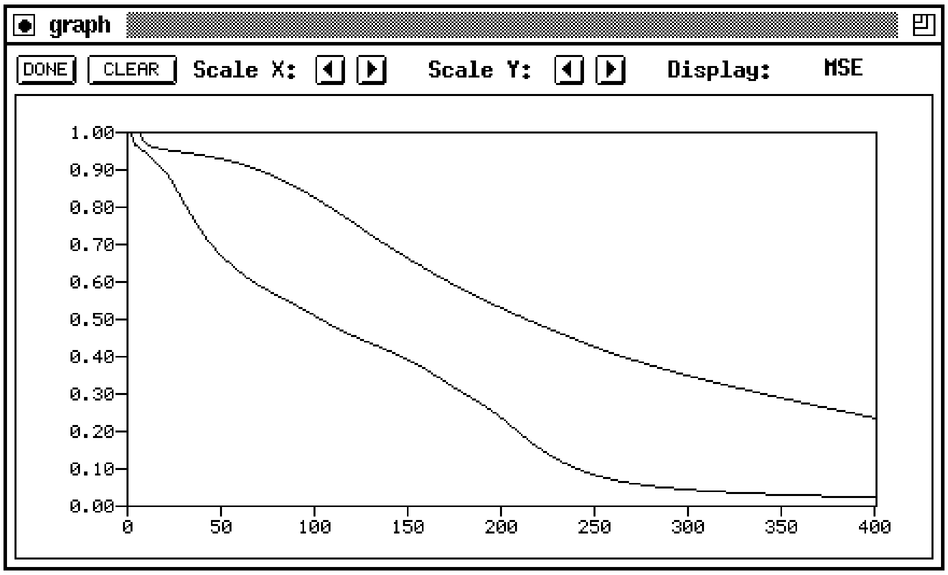

Figure 4.16: Graph window

Graph is only active after calling it. This means, the development of the error is only drawn as long as the window is not closed. The advantage of this implementation is, that the simulator is not slowed down as long as graph is closed[3]. If the window is iconified, graph remains active.

The error curve of the net is plotted until the net is initialized or a new net is loaded, in which case the cycle counter is reset to zero. The window, however, is not cleared until the clear button is pressed. This opens the possibility to compare several error curves in a single display (see also figure 4.16). The maximum number of curves, which can be displayed simultaneously is 25. If a 26^{th} curve is tried to be drawn, the confirmer appears with an error message.

When the curve reaches the right end of the window, an automatic rescale of the x-axis is performed. This way, the whole curve always remains visible.

In the top region of the graph window, seven buttons for handling the display are located:

`CLEAR`: Clears the screen of the graph window and sets the cycle counter to zero.

`DONE`: Closes the graph window and resets the cycle counter.

For both the x– and y–axis the following two buttons are available:

: Reduce scale in one direction.

: Enlarge scale in one direction.

`SSE`: Opens a popup menu to select the value to be plotted. Choices are `SSE`, `MSE`, and `SSE/out`, the SSE divided by the number of output units.

While the simulator is working all buttons are blocked.

The graph window can be resized by the mouse like every X-window. Changing the size of the window does not change the size of the scale.

When validation is turned on in the control panel two curves will be drawn simultaneously in the graph window, one for the training set and one for the validation set. On color terminals the validation error will be plotted as solid red line, on B/W terminals as dashed black line.

4.3.7 Weight Display

The weight display window is a separate window specialized for displaying the weights of a network. It is called from the manager panel with the `WEIGHTS` button, or by typing Alt-w in any snns window. On black-and-white screens the weights are represented as squares with changing size in a Hinton diagram, while on color screens, fixed size squares with changing colors (WV-diagrams) are used. It can be used to analyze the weight distribution, or to observe the weight development during learning.

Initially the window has a size of 400x400 pixel.The weights are represented by 16^2 pixels on B/W and 5^2 pixels on color terminals. If the net is small, the square sizes are automatically enlarged to fill up the window. If the weights do not fit into the window, the scrollbars attached to the window allow scrolling over the display.

[3]The loss of power by graph should be minimal.

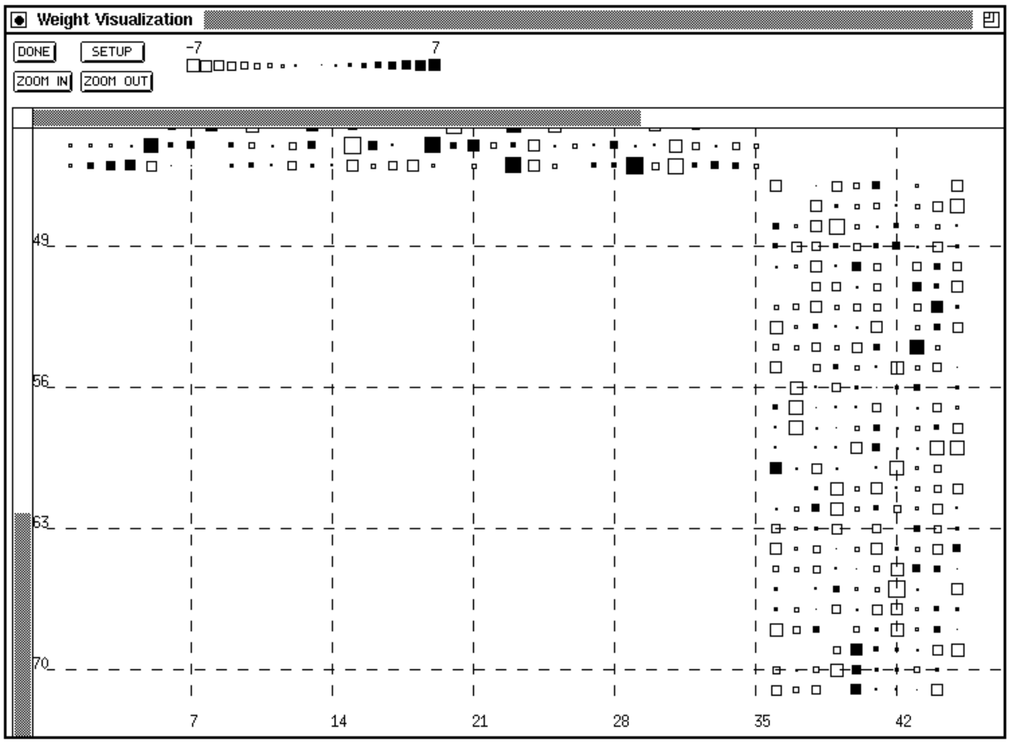

Figure 4.17: A typical Hinton diagram

These settings may be changed by the user by pressing the ZOOM IN and ZOOM OUT buttons in the upper part of the window. ZOOM IN enlarges the weight square by one pixel on each side, while ZOOM OUT shrinks it.

The setup panel lets the user change the look of the display further. Here the width of the underlying grid can be changed. If the grid size is bigger than the number of connections in the network, no grid will be displayed. Also the color scale (resp. size scale for B/W) can be changed here. The initial settings correspond to the SNNS variables `max_weight` and `min_weight`.

In a Hinton diagram, the size of a square corresponds to the absolute size of the correlated link. A filled square represents positive, an square frame negative links. The maximum size of the squares is computed automatically, to allow an optimal use of the display. In a WV diagram color is used to code the value of a link. Here, a bright red is used for large negative values and a bright green is used for positive values. Intermediate numbers have a lighter color and the value zero is represented by white. A reference color scale is displayed in the top part of the window. The user also has the possibility to display the numerical value of the link by clicking any mouse button while the mouse pointer is on the square. A popup window then gives source and target unit of the current link as well as its weight.

For a better overall orientation the numbers of the units are printed all around the display and a grid with user definable size is used. In this numbering the units on top of the screen represent source units, while numbers to the left and right represent target units.

4.3.8 Projection Panel

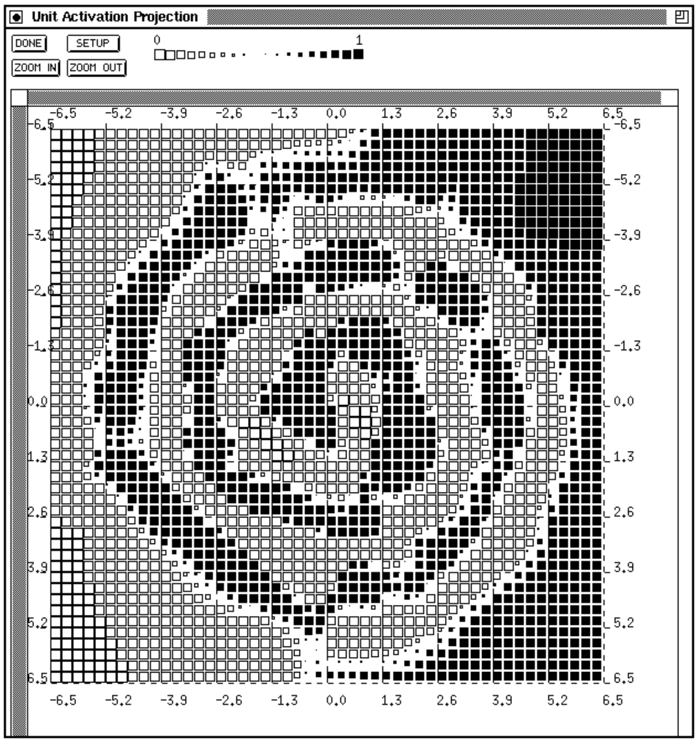

Figure 4.18: PROJECTION panel for the 2-spirals problem. Note that the input range of the X and Y units must be specified, not the output range. In contrast, the output range of the third unit specified determines the color. Here the following values have been used: X-axis: unit 1 value range -6.5 to 6.5; Y-axis: unit 2 value range -6.5 to 6.5; activation pattern: unit 38 (the only output unit of the network) value range 0 to 1

The projection analysis tool allows to display how the output of one unit (e.g. a hidden or an output unit) depends on two input units. It thus realizes a projection to two input vector axes.

It can be called by clicking the `PROJECTION` button in the manager panel or by typing Alt-p in any SNNS window. The display of the projection panel is similar to the weights display, from which it is derived.

in the setup panel, two units must be specified, whose inputs are varied over the given input value range to give the X resp. Y coordinate of the projection display. The third unit to be specified is the one whose output value determines the color of the points with the given X and Y coordinate values. The range for the color coding can be specified as output range. For the most common logistic activation function this range is $[0, 1]$.

The use of the other buttons, ZOOM IN, ZOOM OUT and DONE are analogous to the weight display and should be obvious.

The projection tool is very instructive with the 2-spirals problem, the XOR problem or similar problems with two-dimensional input. Each hidden unit or output unit can be inspected and it can be determined, to which part of the input space the neuron is sensitive. Comparing different networks trained for such a problem by visualizing to which part of the input space they are sensitive gives insights about the internal representation of the networks and sometimes also about characteristics of the training algorithms used for training. A display of the projection panel is given in figure 4.18.