5.9 The conditional distribution of targets becomes:

$$p(t|\mathbf{x}, \mathbf{w}) = y(\mathbf{x}, \mathbf{w})^{(t+1)/2}\{1 - y(\mathbf{x}, \mathbf{w})\}^{1-(t+1)/2}$$

$$= y(\mathbf{x}, \mathbf{w})^{(t+1)/2}\{1 - y(\mathbf{x}, \mathbf{w})\}^{(1-t)/2}$$

It can be easily seen that when $t = 1$, $(t+1)/2 = 1$ and $(1-t)/2 = 0$, and when $t = -1$, $(t+1)/2 = 0$ and $(1-t)/2 = 1$. Since y is modeling t, it will also have the same range and will have to be transformed similarly.

The error function becomes:

$$E(\mathbf{w}) = -\sum_{n=1}^{N}\left\{\frac{(t_n+1)}{2}\ln\left(\frac{y_n+1}{2}\right) + \frac{(1-t_n)}{2}\ln\left(\frac{1-y_n}{2}\right)\right\}$$

$$= -\frac{1}{2}\sum_{n=1}^{N}\left\{(t_n+1)\ln\left(\frac{y_n+1}{2}\right) + (1-t_n)\ln\left(\frac{1-y_n}{2}\right)\right\}$$

$$= -\frac{1}{2}\sum_{n=1}^{N}\{(t_n+1)\ln(y_n+1) - (t_n+1)\ln 2 + (1-t_n)\ln(1-y_n) - (1-t_n)\ln 2\}$$

$$= -\frac{1}{2}\sum_{n=1}^{N}\{(t_n+1)\ln(y_n+1) + (1-t_n)\ln(1-y_n) - (t_n+1+1-t_n)\ln 2\}$$

$$= -\frac{1}{2}\sum_{n=1}^{N}\{(t_n+1)\ln(y_n+1) + (1-t_n)\ln(1-y_n) - 2\ln 2\}$$

$$= -\frac{1}{2}\sum_{n=1}^{N}\{(t_n+1)\ln(y_n+1) + (1-t_n)\ln(1-y_n)\} + N\ln 2$$

We can find an appropriate activation function, by performing the inverse of the above transformation on the logistic sigmoid function.

$$h(a) = 2\sigma(a) - 1$$

$$= \frac{2}{1+e^{-a}} - 1$$

$$= \frac{2 - (1 + e^{-a})}{1 + e^{-a}}$$

$$= \frac{1 - e^{-a}}{1 + e^{-a}}$$

$$= \tanh(a/2)$$