T-61.5030 Advanced course in neural computing

Solutions for exercise 1

1. (a) Learning type: error-correction learning, memory-based learning, Hebbian learning, or competitive learning.
   (b) Category of architecture: feedforward network, recurrent network, competitive network.
   (c) Type of task: supervised, unsupervised, reinforcement learning.
   (d) Functions of neurons: projections or distances from points in space.
   (e) Suitable for these tasks: pattern association, pattern recognition, function approximation, control, filtering, density estimation, visualization, summarization, other

	P	MLP	RBF	SOM
(a)	ecl			cl
(b)	feedforward			cn
(c)	supervised l			usl
(d)	projections		both	dfp

(e)	P	MLP	RBF	SOM
pa				s
pr	s	W	W	s
fa		W	W	s
c		W	W	s
f		s	s	s
de				s
v				W
s				W

W: well suited
s: to some extent

2. In the following, E_y denotes the expectation over y. Assuming that $\mathbf{x}$ and $\mathcal{T}$ are fixed, $E_\epsilon\{\epsilon\} = 0$ and $d = f(\mathbf{x}) + \epsilon$, it follows that

$$\mathcal{E}(\mathbf{x}) = E_\epsilon\{(d - F(\mathbf{x}, \mathcal{T}))^2\} = E_\epsilon\{(f(\mathbf{x}) - F(\mathbf{x}, \mathcal{T}) + \epsilon)^2\} = (f(\mathbf{x}) - F(\mathbf{x}, \mathcal{T}))^2 +$$
$$2(f(\mathbf{x}) - F(\mathbf{x}, \mathcal{T}))E_\epsilon\{\epsilon\} + E_\epsilon\{\epsilon^2\} = (f(\mathbf{x}) - F(\mathbf{x}, \mathcal{T}))^2 + E_\epsilon\{\epsilon^2\}.$$

3. For a fixed $\mathbf{x}$,

$$E_\mathcal{T}\{(f(\mathbf{x}) - F(\mathbf{x}, \mathcal{T}))^2\} = E_\mathcal{T}\{(f(\mathbf{x}) - E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} + E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} - F(\mathbf{x}, \mathcal{T}))^2\} =$$
$$(f(\mathbf{x}) - E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\})^2 + 2(f(\mathbf{x}) - E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\})E_\mathcal{T}\{E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} - F(\mathbf{x}, \mathcal{T})\} +$$
$$E_\mathcal{T}\{(E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} - F(\mathbf{x}, \mathcal{T}))^2\}.$$

The second term vanishes because

$$E_\mathcal{T}\{E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} - F(\mathbf{x}, \mathcal{T})\} = E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} - E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\} = 0.$$

Hence

$$E_\mathcal{T}\{(f(\mathbf{x}) - F(\mathbf{x}, \mathcal{T}))^2\} = (f(\mathbf{x}) - E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\})^2 + E_\mathcal{T}\{(F(\mathbf{x}, \mathcal{T}) - E_\mathcal{T}\{F(\mathbf{x}, \mathcal{T})\})^2\}.$$