

## **Series 6, Dec 12th, 2016 (Neural Networks)**

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**For questions :**

**Please turn in solutions until Friday, Dec 16th.**  
(“\*”-exercises are a little bit more difficult, but still useful)

### **Problem 1 (Backpropagation for classification):**

Derive the backward propagation equations for the cross-entropy loss function of a  $L$  layer NN.

### **Problem 2 (Maximum likelihood estimator for regression):**

Show that maximizing the likelihood function under the conditional distribution

$$p(t|x, w) = N(t|y(x, w), \beta^{-1}I)$$

for a multioutput neural network (1 hidden layer) is equivalent to minimizing the sum-of-squares error function:

$$E(w) = \frac{1}{2} \sum_{n=1}^N \|y(x_n, w) - t_n\|^2$$

### **Problem 3 (Maximum likelihood estimator for classification):**

Show that maximizing likelihood for a multiclass neural network model (1 hidden layer) in which the network outputs have the interpretation

$$y_k(x, w) = p(t_k = 1|x)$$

is equivalent to the minimization of the cross-entropy error function:

$$E(w) = - \sum_{n=1}^N \sum_{k=1}^K t_{kn} \ln y_k(x_n, w)$$