Departamento de Teoría de la Señal y Comunicaciones **17/09/03**
UCIIIM

TRATAMIENTO DIGITAL DE SEÑALES

THEORETICAL PART

(Time: 60 minutes. Points: 3/8)

T1. - Describe the two fundamental approaches to train radial basis function (RBF) networks. Discuss their respective advantages.

(20 min; 1 p)

T2. - What are the advantages of using a linear model as opposed to a nonlinear model? What are the advantages of a nonlinear model?

(20 min; 1 p)

T3. - Briefly describe gradient descent with momentum. What is its potential advantage against standard gradient descent?

(20 min; 1 p)

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PROBLEMS

(Time: 120 minutes. Points: 5/8)

Problem 1:

A financial analyst discovers an exceptional performance of the Timbuktu stock exchange index (TUTSE) during the last 10 months:

x	2	4	6	10
y	2	3	10	24.76

x: months after beginning of observation (start: 10 months ago)
y: increase in % (compared to the index 10 months ago)

He suspects there is a relationship of the form: $y = w\, x^2$. Since he is not very familiar with least-squares techniques, he asks you to find the least-squares solution for the parameter w, given his data.

A.) Compute the value of w that minimizes the sum of squared errors (SSE) for the given data. Also report the value of the pseudo-inverse.

B.) Compute the SSE and MSE for the obtained model.

C.) The analyst would like to convince his bank to make a substantial investment in Timbuktu. He asks you to make a prediction for the next two months: How much (in %) will the index have gained in two months from now, according to your model, compared to the current value?

D.) Does it make sense to trust in this prediction? Discuss it briefly.

(60 min; 2.5 p)

Problem 2:

A bank has developed a sophisticated scoring function for credit risk. In three cases of credits that were lost due to bankruptcy of the clients, the function yielded the values X- = {-5, -4, -3}. For three successful credit deals, the function returned X+ = {0, 2, 4}. A student is hired to build a classifier on top of it. He assumes that the scores for each of the two classes have a Gaussian distribution (class C+ for safe credits and class C- for high-risk credits).

A.) Following his assumption, determine the unbiased estimates of the class-conditional probability density functions, p(x|C+) and p(x|C-), from the given data.

B.) Since there isn't any further information, the student assumes that the prior probabilities of both classes are the same. Compute the decision boundaries of the maximum-posterior classifier (MAP) accordingly.

C.) A new client asks for a credit. The scoring function yields a value of x = -11. How is it classified by the MAP classifier? Does it make sense? What is the problem with the approach taken by the student? Discuss it briefly.

(60 min; 2.5 p)