SGN-41006 Signal Interpretation Methods, Spring 2014
Exam 1 on March 10, 2015 / Jari Niemi and Katariina Mahkonen

No literature. Use of your own calculator allowed. Use either English or Finnish in your answers. You can keep this paper also after the exam.

Choose freely two (2) of the three (3) essay topics E1 – E3 and answer to them using approx. 200-500 words per each essay topic. You can also draw illustrative pictures if you like. You do not need to cover everything what is said in the course textbook(s) about the topic (especially you can omit mathematical derivations) but you need to give a summary (essay) which shows that you have understood the meaning and diversity of the topic from the point of view of pattern classification and/or regression.

In addition, answer to both of the calculation problems C1 – C2.

Altogether you need to give four (4) answers, each worth of 6 points.

ESSAY TOPICS

E1. Finite Mixture Models in Parametric Density Estimation.
E2. Performance Assessment.
E3. Feature Selection and Extraction.

CALCULATION PROBLEMS

C1. Explain the meaning and purpose of use of the formulas below. Especially, describe the meaning of each term ($y_i, x_{ij}, \beta_j, \hat{\beta}^{\text{lasso}}, N, p, t$) occurring in them.

$$\hat{\beta}^{\text{lasso}} = \text{argmin}_\beta \left\{ \sum_{i=1}^{N} \left(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_j \right)^2 \right\}$$

$$\text{subject to} \sum_{j=1}^{p} |\beta_j| \le t.$$

C2. Let $\hat{p}(\mathbf{x}) = k/(nV)$ be the k nearest neighbors density estimate of the continuous density function $p(\mathbf{x})$. Starting from this $\hat{p}(\mathbf{x})$ derive the joint k nearest neighbors density estimate of $\mathbf{x}$ and ω_i,

$$\hat{p}(\mathbf{x}, \omega_i) = \frac{k_i}{nV},$$

where $\mathbf{x}$, n, and V are the same as in $\hat{p}(\mathbf{x}) = k/(nV)$, but k_i is the number of samples belonging to the class ω_i among the k samples. Justify your answer carefully. Especially: explain why the same V suits both for $\hat{p}(\mathbf{x})$ and $\hat{p}(\mathbf{x}, \omega_i)$.