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Examination in Statistical Image Analysis, March 12, 2004

Course code Chalmers: TMS016, Gothenburg University: Statistisk Bildbehandling

Written examination March 12, 2004, 14.15-18.15 in house V.

Literature and notes may be brought for this written examination. All types of pocket calculators are allowed but not computers. In the written examination there are two pages and two problems. You are supposed to answer both problems, and in the judgement they have the same weight. Answers may be given in English or Swedish.

Problem 1.

In a two-colour microarray experiment images were obtained separately for two colour channels: green cy3 (here corresponding to wild-type Arabidopsis) and red cy5 (here corresponding to one transgenic Arabidopsis line). Figure 1 below shows signal intensity for one spot, actually the sixth spot in the fourth row of the microarray corresponding one particular gene, in the green channel left and in the red channel right. The signal is registered in two bytes, and the signal thus lies between 0 and $2^{16} - 1 = 65535$. We are interested in comparing the expression level of the transgenic line relative to the wildtype. The relative expression level is the ratio of the integrated signal intensity in the red channel and the integrated signal intensity in the green channel, possibly corrected by subtracting the noise level which may be different in the two channels.

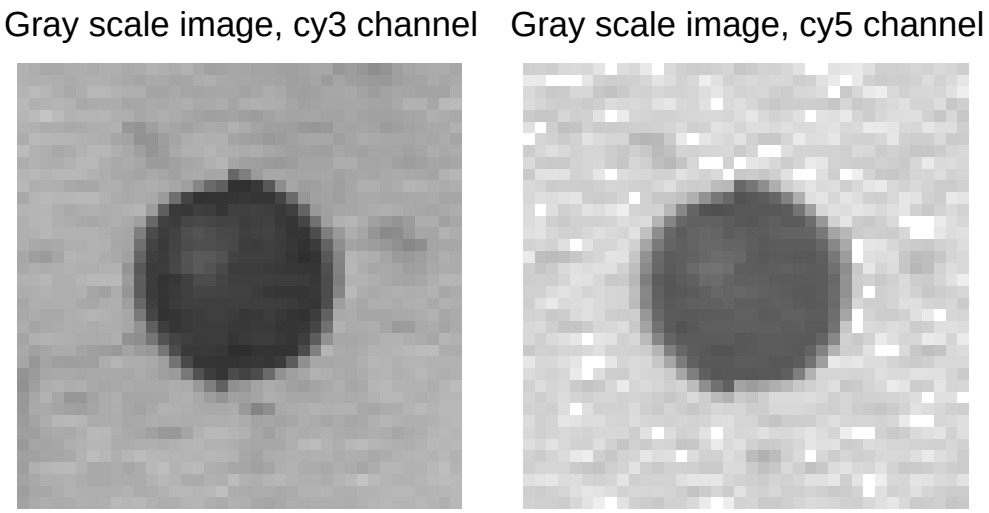

Figure 1: Green and red channel images of one spot in a microarray experiment. In the images black corresponds to high signal intensity. In each image we have 38×38 pixels.

a) Suggest a method for estimating the relative expression level without correcting for different background levels in the two channels. Let for instance

$G(x)$ and $R(x)$ denote the measured signal levels in the green and red channels at pixel $x = (x_1, x_2)$.

b) Suggest now a method for estimating the relative expression level with correction for the background level. Assume that in each of the two images the background consists of an additive constant plus independent zero mean noise.

c) Suggest finally a method for estimating the relative expression level with correction for the background when we assume that the background consists of a level which varies linearly in the pixel coordinates x_1 and x_2 over the image plus independent zero mean noise.

Problem 2. An important problem in analysis of some Drosophila experiments is to have an accurate method for discriminating between males and females. One possibility is to use characteristics of wings. Suppose that you have a method of acquiring images such as the image shown in Figure 2 and a program for finding the coordinates of the 13 landmarks marked with circles in the figure.

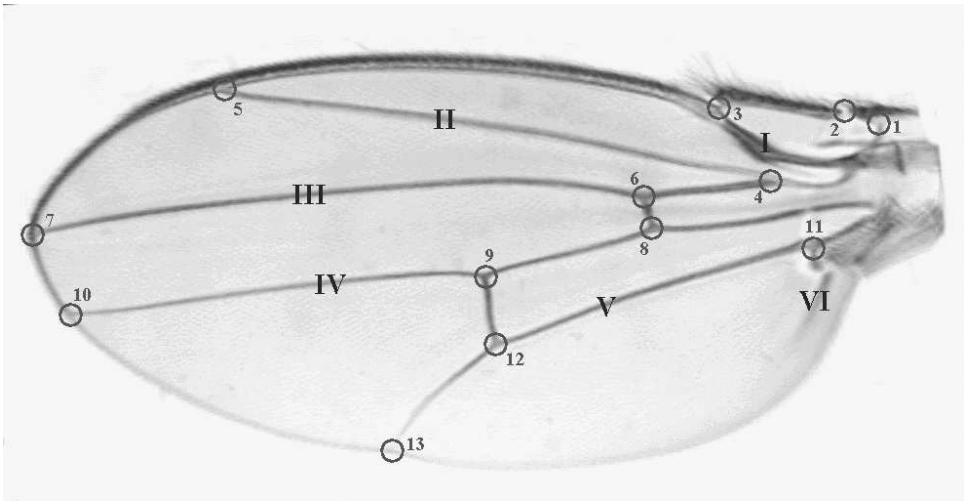

Figure 2: Drosophila wing with 13 landmarks, image from http://www.bio.umass.edu/biology/kunkel/

Suggest an experiment for testing if it is possible to discriminate between males and females by use of the wing characteristics in Figure 2. Introduce suitable notation and describe how you would analyze the data and how you would try to find suitable features for the discrimination.