

Pattern Recognition I

Homework 4

Due 11/1/2004

- Read any one of the following papers from the ACM Multimedia 2004 conference and write a review on it. You should follow the format from the first three parts of the technical paper review form for the IEEE Transactions. A copy of it can be found in <http://www.vis.uky.edu/~cheung/courses/ee639/homeworks/review.html>. In your “Detailed Comment” section, you should summarize the major contributions of the paper, state the strengths and weaknesses of the paper, and evaluate the research and societal impact. Here are the papers and their links in the course website:
 - Privacy Protecting Data Collection in Media Spaces (homeworks/p48.pdf)
 - Multi-level annotation of natural scenes using Dominant Image Components and Semantic Concepts (homeworks/p540.pdf)
 - Family Ensemble: A Collaborative Musical Edutainment System for Children and Parents (homeworks/p556.pdf)
 - Passive Capture and Ensuing Issues for a Personal Lifetime Store (homeworks/d48.pdf)
- Many standard software packages such as Matlab allow you to generate samples from a univariate gaussian distribution. We can concatenate these samples into a vector and thereby obtain samples from a multivariate gaussian distribution with diagonal covariance matrix. But how do we obtain samples from a multivariate gaussian distribution with arbitrary covariance matrix Σ ? Submit a working matlab script and demonstrate your solution by generating 100 samples from a bivariate Gaussian distribution with non-diagonal covariance matrix.
- Let x, y be d -dimensional vectors and A be a $d \times d$ matrix. Prove the followings:
 - $\frac{\partial}{\partial x} x^T y = y^T$
 - $\frac{\partial}{\partial x} x^T A x = x^T A + x^T A^T$
 - $\frac{\partial}{\partial A} x^T A x = x x^T$ (Hint: first show that $\text{trace}(ABC) = \text{trace}(CAB) = \text{trace}(BCA)$.)
 - $\frac{\partial}{\partial A} \log |A| = A^{-1}$
- In this exercise, you will build a background subtraction model using a Gaussian mixture model. The basic concept is as follows: assume there is no foreground object in the scene during the training phase. A GMM background distribution model is constructed at each pixel location (x, y) :

$$f_{(x,y)}(p) = \sum_{i=1}^M \alpha \cdot g_{(x,y)}^i(p) \quad (1)$$

where $g_{(x,y)}^i(p)$ is a gaussian distribution. The advantage of using a GMM model is that it can model non-stationary background such as swinging leaves or changing billboard. In the monitoring phase, the system monitors each new video frame I and declares $I(x, y)$ as a foreground pixel if its probability of belonging to the background distribution at (x, y) is smaller than a certain threshold Γ .

Download the following training sequence (homeworks/data/traffic_train.zip) and build a GMM model with three components for each pixel location. Then, test your algorithm on a test frame and compare

your results with the ground-truth. Both the test frame and its ground-truth is stored in `home-works/data/traffic_test.zip`. In the ground-truth frame, a non-zero pixel value indicates a foreground pixel. Submit all your matlab files as well as a precision-recall plot by changing the value of Γ .