Pattern Recognition Exercises
Sheet 5 "Template Matching and Context Dependent Classification"

Exercises: M.Sc. Chen Li, M.Sc. Cong Yang
Lectures: Prof. Dr.-Ing. Marcin Grzegorzek
Pattern Recognition Group, University of Siegen
http://www.pr.informatik.uni-siegen.de

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File Name:	PR-ES5-Surname.pdf
Exercise Discussion:	July 1, 2014, 8:30am, H-F 001

1 Template Matching - System Design (12 Points)

Please design a system for classification of road signs in Germany which follows the template matching principle. The system should be mounted on cars and work in real-time. Its processing chain in the recognition phase should look like follows:

Acquisition (Sensor) → Preprocessing → Feature Extraction → Matching Algorithm

For all processing steps a description of how would you approach the problem and why would you choose this approach should be given. More specifically, the following questions have to be answered:

1. What kind of sensor would you use and why?
2. What kind of preprocessing would you apply and why?
3. What kind of features would you extract and why?
4. What kind of matching algorithm including the similarity measure between the test and the reference template would you go for and why?

Please take into consideration that the system should work in a real environment (varying illumination, rotated signs, partly destroyed or occluded signs). How would you setup the reference training dataset?

2 Content-Based Information Retrieval (8P)

Please define *precision* and *recall*, the coefficients used for evaluation of IR systems. Please explain why both of them must be used for an objective evaluation of an IR system. For this, please give two negative examples, i. e.,

- an example of a bad IR system achieving 100% of precision, and
- an example of a bad IR system achieving 100% of recall.

3 Context-Dependent Classification - Markov Models (10P)

Consider a simple Markov model of weather with four observable states:

s_1 – state 1: rainy

s_2 – state 2: snowy

s_3 – state 3: cloudy

s_4 – state 4: sunny

We assume that the weather on day t is characterised by a single one of the four states above, and that the matrix $\boldsymbol{A}$ of the state transitions probabilities is

$$\boldsymbol{A} = \{a_{ij}\} = \begin{bmatrix} 0.4 & 0.2 & 0.3 & 0.1 \\ 0.2 & 0.5 & 0.1 & 0.2 \\ 0.3 & 0.1 & 0.4 & 0.2 \\ 0.1 & 0.1 & 0.2 & 0.6 \end{bmatrix} \quad .$$

Draw a graphical representation of this model. Given that the weather on day 1 ($t = 1$) is snowy (state 2), compute the probability that the weather for the next five days will be: "snowy-rainy-rainy-sunny-sunny".