Pattern Recognition 36125321

(זיהוי צורות)

נקודות זכות: 3

Graduate course, Semester Bet 2019, Wednesdays, 17:00-21:00.
The course will start on 3/04/2019 until 19/06/2019 (9 weeks), each week 4 hours.
One-hour introduction lecture for the course on 27/02/2019.

Instructor: Prof. Mayer Aladjem (Retired Associate Professor)
http://www.ee.bgu.ac.il/~aladjem

This course is intended to be largely self-contained.
It is suitable for all fields of engineering specializations.

General prerequisites: Basic undergraduate mathematical courses. Programming Matlab.

Course Description: The course consists of 13 topics that introduce basic methods in statistical pattern recognition, known as **"Machine Learning"** also. Pattern recognition is a practical technology with successful applications in many fields. The learned material provides comprehensive information, including algorithms and procedures, for designing effective, practical pattern recognition systems. The course addresses the problems of feature evaluation, pattern classification and performance estimation.

The students will work on individual project covering the learned methods. Each of them will study the methods on specific synthetic data sets generated by him/her. The instructor will define the type and parameters of the data for each student.

The course will provide a broad theoretical and practical knowledge in the basic statistical methods for pattern recognition. Upon successful completion of the course, the students should be able to exploit the learned methods in the specific data analysis studies in the research and/or work and understand advanced methods for pattern recognition published in the journals.

The lecture handouts will be available before the class in
http://moodle2.bgu.ac.il/?lang=en

Attendance regulation: 5% of the final grade is compulsory attendance in at least 80% of the classes. The attendance in the lectures is critical for student's success in the project and the course.

Assessment:

Compulsory attendance in at least 80% of the classes: 5%

Project: 95% (including interview on the projects and course topics, which will be around 30 min. with each student)

The project contains three parts formulated during the teaching of topics 6, 8 and 10 respectively (see course topics on the next page).

Learning outcomes: The student will have a thorough understanding of:

1. Optimal decision-making and feature extraction.
2. Decision making with rejection option.
3. Plug-in-Bayes decision.
4. Methods for evaluation of the classification performance.
5. Sequential classification.
6. Nearest neighbor (NN) decision rule.
7. Various data normalizations and metrics in NN decision rule.
8. Probability density function estimation.
9. Linear and generalized linear discriminant functions.
10. Recent discriminant methods – kernel, sparse, neural networks, deep learning.
11. Feature selection and feature extraction.

Course topics:

1) Overview of the approaches to automatic pattern recognition – statistical, neural network, fuzzy, linguistic and hybrid approaches. Examples of pattern recognition problems. Two-step model for statistical pattern recognition. Basic pattern recognition terminology.

2) Random vectors and their properties. Explanation of the procedures for generation synthetic data sets used in the project of the course.

3) Bayes decision theory. Model of decision making. Optimal decision making. Optimal feature extraction. Decision making with rejection option. Pattern recognition performance characteristics.

4) Interpretation of the optimality of Bayes decision rule with rejection option. Compromise between performance characteristics. Relations between performance characteristics.

5) Plug-in-Bayes decision rule. Methods for evaluation of the classification performance – re-substitution, holdout, leave-one-out, cross validation (CV), Monte-Carlo CV, bootstrap and other methods. Over-fitting phenomena and "curse of dimensionality".

6) Explanation the first part of the project and discussions. Bayes rule in the case of normal class-conditional densities. Mahalanobis distance. Whitening transformation. Theoretical and computational difficulties in the classification performance evaluation. Error bounds.

7) Nearest neighbor decision rule: homogeneous and non-homogeneous relationships, editing technique, condensing technique, finite –sample considerations.

8) Discussions on various options for data normalizations, and suitable metrics in nearest neighbor decision rules. Explanation of the second part of the project and discussions.

9) Probability density function estimation: parametric and nonparametric. Parzen estimator. K-nearest neighbor method.

10) Linear and generalized linear discriminant functions. Least mean-squared-error (LMSE) procedure. Properties of LMSE linear discriminant analysis. Explanation of the third part of the project and discussions.

11) Selection suitable preliminary nonlinear transformations in LMSE linear discriminant analysis. Recent discriminant methods – kernel, sparse, SVM, neural networks, deep learning and other.

12) Sequential classification with fixed order of the features. Other alternatives the Bayesian decision.

13) Interclass and between-class distance measures. Feature selection and feature extraction.

Required reading:

1. P. A. Devijver and J. Kittler, "Pattern Recognition : a statistical approach" , Prentice-Hall, 1982.
2. K. Fukunaga, "Introduction to statistical pattern recognition", Academic Press, 1990
3. Selected journal papers.

Additional literature:

1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern classification", Wiley, 2001
2. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.