**Nazwa przedmiotu:**

Pattern Recognition

**Koordynator przedmiotu:**

Rajmund Kożuszek

**Status przedmiotu:**

Fakultatywny dowolnego wyboru

**Poziom kształcenia:**

Studia II stopnia

**Program:**

Informatyka

**Grupa przedmiotów:**

Przedmioty techniczne - zaawansowane

**Kod przedmiotu:**

EPART

**Semestr nominalny:**

4 / rok ak. 2018/2019

**Liczba punktów ECTS:**

6

**Liczba godzin pracy studenta związanych z osiągnięciem efektów uczenia się:**

30 hours of lectures
24 hours preparation for tests
15 hours of laboratory exercises
20 hours of preparation for the laboratory exercises
15 hours of project meetings
40 hours of implementation of project assignments

**Liczba punktów ECTS na zajęciach wymagających bezpośredniego udziału nauczycieli akademickich:**

30 hours of lecture
15 hours of laboratory exercises
15 hours of project meetings
which gives approx. 2.5 ECTS

**Język prowadzenia zajęć:**

angielski

**Liczba punktów ECTS, którą student uzyskuje w ramach zajęć o charakterze praktycznym:**

15 hours of laboratory exercises
20 hours of preparation for laboratory exercises
15 hours of project meetings
40 hours of implementation of project assignments
which gives approx. 4 ECTS

**Formy zajęć i ich wymiar w semestrze:**

|  |  |
| --- | --- |
| Wykład: | 30h |
| Ćwiczenia: | 0h |
| Laboratorium: | 15h |
| Projekt: | 15h |
| Lekcje komputerowe: | 0h |

**Wymagania wstępne:**

basic knowledge of linear algebra and probability theory

**Limit liczby studentów:**

24

**Cel przedmiotu:**

The aim of the lecture is to present pattern recognition issues. Particularly general classification of pattern recognition approaches together with selected pattern recognition methods and techniques will be presented. Also issues concerning data acquisition, image segmentation and pattern dimensionality reduction will be discussed. Examples of applications of the discussed methods in recognition systems (together with project realised during the course) will allow listeners to analyse practical aspects of pattern recognition.
Classes have been prepared and are conducted using the competences and skills in the field of searching and verification of information, communication, information presentation, and information distribution management.

**Treści kształcenia:**

Introduction: the components of the image recognition system; classifier design cycle; quality of classifiers and classification systems assessment methods.
Optimal Bayesian classification: the role of a priori information; the form of a probability density function; Bayesian optimal classifier; consideration of the risks and losses when constructing a classifier; decision boundaries of classifiers; compliance data distribution with the adopted theoretical distribution.
Nearest neighbor methods: template matching; minimum-distance classifiers; metrics; k-NN classifiers; nearest neighbor search methods; nearest neighbor search acceleration; editing and reduction of the training set.
Linear classifiers: linear classification functions; homogeneous space; determining the decision boundary: support vector machine; sequential minimal optimization algorithm.
Dimensionality reduction: Principal Component Analysis; Fisher's linear classification; multivariate discriminant analysis (MDA).
Clustering: definition of clustering problem; assessment of the similarity of clustering; k-means algorithm; bottom-up clustering; graph algorithms; density based clustering (DBSCAN).
Neural networks: the basic model of the neuron; training algorithms for a single neuron; interpretation of a single neuron operation; neural networks; error backpropagation algorithm; network with feedback loops; associative memory; Hopfield memory; Kohonen self-organizing network; ART networks.
Markov models: discrete Markov processes; hidden Markov process; forward and backward procedures; Viterbi algorithm; Baum-Welsha procedure; using Markov models in classification.
Text searching: exact and approximate text matching; Boyer-Moore algorithm; edit distance; text analysis using non-deterministic and deterministic automata; suffix tree and suffix array; Ukkonen algorithm for constructing the suffix tree; approximate search with suffixe tree; neighborhood generation for search with errors; hash functions for fast searching.
Decision trees: construction of decision trees: basic CART algorithm; assessment of heterogenity of tree nodes; stop criteria when generating the tree; the effect of the horizon; tree pruning algorithms.
Improving the quality of classification: basic problems of constructing metaclassifiers; majority voting; the independence of the classifiers; weighted voting; determination of weights; Bayesian methods for combining of classification results; Behavior-Knowledge Space; bagging and boosting (AdaBoost algorithm); the use of contextual information in the classification; context in OCR systems; use of trigrams and dictionaries.

**Metody oceny:**

two tests (on the 7th and penultimate lecture)
3 laboratory exercises (unrated introduction, 2 exercises rated on a scale 0-6)
2 mini-projects (4 project meetings) rated on a scale 0-12

**Egzamin:**

nie

**Literatura:**

Duda R.O., Hart P.E., Stork D.G., Pattern Classification, Wiley-Interscience, 2000
Stąpor K., Automatyczna klasyfikacja obiektów, Exit, Warszawa 2005
Jain A. K., Fundamentals of Digital Image Processing, Prentice-Hall International Editions, Engelwood Hills, 1989
Tadeusiewicz R., Korohoda P., Komputerowa analiza i przetwarzanie obrazów, Wydawnictwo Fundacji Postępu Telekomunikacji, Kraków 1997
Press W. H., Numerical Recipes in C, Cambridge University Press, Cambridge 1992 (lub późniejsze wydania)

**Witryna www przedmiotu:**

https://usosweb.usos.pw.edu.pl/kontroler.php?\_action=katalog2/przedmioty/pokazPrzedmiot&prz\_kod=103C-CSCSN-MSA-EPART

**Uwagi:**

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## Charakterystyki przedmiotowe

### Profil ogólnoakademicki - wiedza

**Charakterystyka EPART\_W01:**

Student knows basic pattern classification methods

Weryfikacja:

test, laboratory excercises, project assignments

**Powiązane charakterystyki kierunkowe:** K\_W12, K\_W06, K\_W08, K\_W09

**Powiązane charakterystyki obszarowe:** I.P7S\_WK, III.P7S\_WK.o, I.P7S\_WG, III.P7S\_WG.o

**Charakterystyka EPART\_W02:**

Student knows preliminary data analysis and clustering methods

Weryfikacja:

test, laboratory excercises, project assignments

**Powiązane charakterystyki kierunkowe:** K\_W06, K\_W08, K\_W09

**Powiązane charakterystyki obszarowe:** I.P7S\_WG, III.P7S\_WG.o

**Charakterystyka EPART\_W03:**

Student knows basic classifiers ensamble construction methods

Weryfikacja:

test, laboratory excercises, project assignments

**Powiązane charakterystyki kierunkowe:** K\_W12, K\_W08

**Powiązane charakterystyki obszarowe:** I.P7S\_WK, III.P7S\_WK.o, I.P7S\_WG, III.P7S\_WG.o

### Profil ogólnoakademicki - umiejętności

**Charakterystyka EPART\_U01:**

Student can analyze a training set, design a simple classifier and evaluate its quality

Weryfikacja:

laboratory excercises, project assignments

**Powiązane charakterystyki kierunkowe:** K\_U01, K\_U06

**Powiązane charakterystyki obszarowe:** I.P7S\_UK, I.P7S\_UW

**Charakterystyka EPART\_U02:**

Student can, on the basis of a training set assessment, choose a classification method and compute its parameters

Weryfikacja:

test, laboratory excercises, project assignments

**Powiązane charakterystyki kierunkowe:** K\_U01, K\_U06, K\_U07

**Powiązane charakterystyki obszarowe:** I.P7S\_UK, I.P7S\_UW, III.P7S\_UW.2.o

**Charakterystyka EPART\_U03:**

Student is able to critically evaluate the solution of the classification problem and propose its improvement

Weryfikacja:

test, laboratory excercises

**Powiązane charakterystyki kierunkowe:** K\_U07, K\_U10, K\_U11

**Powiązane charakterystyki obszarowe:** III.P7S\_UW.2.o, I.P7S\_UW, III.P7S\_UW.3.o