1. Course title: MACHINE LEARNING, Statistical learning

2. Course code ML_SL


4. Level of studies: MSc programme

5. Mode of studies: intramural studies

6. Field of study:
   CONTROL, ELECTRONIC AND INFORMATION ENGINEERING (MACRO) (FACULTY SYMBOL) RAU-2

7. Profile of studies: ACADEMIC

8. Programme: DATA SCIENCE

9. Semester: 2

10. Faculty teaching the course: Faculty of Automatic Control, Electronics and Computer Science

11. Course instructor: Prof. dr hab. inż. Joanna Polańska

12. Course classification: common courses

13. Course status: compulsory/ elective

14. Language of instruction: English


16. Course objectives: The aim of the course is making students familiar with statistical problems related to machine learning, feature engineering for classification, model rank estimation and model selection in the aspect of machine learning, regression models for machine learning, model integration and analyses of significantly correlated datasets.

17. Description of learning outcomes:

<table>
<thead>
<tr>
<th>Nr</th>
<th>Learning outcomes description</th>
<th>Method of assessment</th>
<th>Teaching methods</th>
<th>Learning outcomes reference code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Student understands statistical character of problems arising in classification of data.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2A_W02, K2A_W04</td>
</tr>
<tr>
<td>2</td>
<td>Student understands the notion and character of high throughput data and the importance of adjusting suitable methods for their analysis.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2A_W06, K2A_W07, K2A_W08</td>
</tr>
<tr>
<td>3</td>
<td>Student has knowledge on methods of estimating reliability of classification models.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2A_W07, K2A_W08</td>
</tr>
<tr>
<td>4</td>
<td>Student has knowledge on principles of integration of machine learning methods.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2A_W10, K2A_W26</td>
</tr>
<tr>
<td>5</td>
<td>Student can use different algorithms for feature selection and signature construction.</td>
<td>Laboratory tasks</td>
<td>Laboratory</td>
<td>K2A_U14, K2A_U15, K2A_K01, K2A_K02</td>
</tr>
<tr>
<td>6</td>
<td>Student can use algorithms of integration of statistical models.</td>
<td>Laboratory tasks</td>
<td>Laboratory</td>
<td>K2A_U14, K2A_U15</td>
</tr>
<tr>
<td>7</td>
<td>Student understands the influence of correlations on statistical inference.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2A_W01, K2A_W02</td>
</tr>
</tbody>
</table>
19. Syllabus description:

**Lecture:**

1. Introductory information. Topics and importance of statistical learning in data analysis. Reliability of inference based on classifiers. High throughput data.
4. Regression models as backgrounds for classification methods. Linear and generalized linear regression, logistic regression, Poisson regression, additive models and pursuit regression.
5. Data compression and data representation by unsupervised models. Data mining by unsupervised models.
6. Integration of statistical models. Integration vectors of p-values. Integration of supervised and unsupervised classifiers.
7. Supervised and unsupervised classification methods for significantly correlated datasets.

**Laboratory:**

2. Analysis of the MILE gene expression dataset.
3. Feature engineering.
4. Application of “Spectre” algorithm and program for Maldi ToF proteomic datasets.
8. Problems in analysis of "radiomics" data. Multistep algorithms for radiomics data analysis.
9. Model rank estimation

20. Examination: semester: 2

21. Primary sources:
Shai Shalev-Shwartz, Shai Ben-David, (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.

22. Secondary sources:
T. Hastie, R. Tibshirani, J. Friedman, (2008), The elements of statistical learning, Springer

23. Total workload required to achieve learning outcomes

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Teaching mode</th>
<th>Contact hours / Student workload hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>30/30</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>/</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30/30</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>/</td>
</tr>
<tr>
<td>5</td>
<td>BA/ MA Seminar</td>
<td>/</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>60/60</td>
</tr>
</tbody>
</table>

24. Total hours: 120

25. Number of ECTS credits: 4

26. Number of ECTS credits allocated for contact hours: 2

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 2
26. Comments:

Approved:

.................................................
(date, Instructor’s signature)

.................................................
(date, the Director of the Faculty Unit signature)