Machine learning in remote sensing

Course description sheet

Basic information

Field of study Geospatial Computer Science **Major** - **Organisational unit** Faculty of Geo-Data Science, Geodesy, and Environmental Engineering **Study level** First-cycle (engineer) programme **Form of study** Full-time studies **Profile** General academic	**Didactic cycle** 2023/2024 **Course code** DIGPS.Ii20.14174.23 **Lecture languages** English **Mandatoriness** Elective **Block** Elective Modules in Foreign Language **Course related to scientific research** Yes

Course coordinator	Wojciech Drzewiecki
Lecturer	Wojciech Drzewiecki

Period Semester 6	**Method of verification of the learning outcomes** Completing the classes **Activities and hours** Lectures: 10 Workshop classes: 20	**Number of ECTS credits** 3

Goals

C1	Transfer of knowledge on the use of machine learning methods to solve tasks in the area of remote sensing

Course's learning outcomes

Code	Outcomes in terms of	Learning outcomes prescribed to a field of study	Methods of verification
Knowledge – Student knows and understands:			
W1	basic machine learning methods and techniques used to solve remote sensing tasks	GI1A_W01, GI1A_W06	Report, Test results, Oral answer
Skills – Student can:			
U1	choose the right machine learning methods to solve selected remote sensing tasks	GI1A_U03	Activity during classes, Execution of a project, Report, Oral answer
U2	evaluate and compare the results obtained using different machine learning techniques	GI1A_U01, GI1A_U07	Activity during classes, Execution of a project, Report, Oral answer
Social competences – Student is ready to:			
K1	responsible use of learned machine learning techniques in practice, while being aware of their possibilities and limitations	GI1A_K01, GI1A_K05	Activity during classes, Execution of a project, Report, Oral answer

Program content ensuring the achievement of the learning outcomes prescribed to the module

Basic machine learning methods used to solve remote sensing tasks and techniques for their implementation.

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Lectures	10
Workshop classes	20
Contact hours	5
Preparation of project, presentation, essay, report	30
Realization of independently performed tasks	10
Student workload	**Hours** 75
Workload involving teacher	**Hours** 30

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities
1.	Introduction to machine learning applications in remote sensing - applicability, processing steps, main concepts and techniques. Applications in regression and classification tasks. Image data mining. Deep learning in remote sensing.	W1, U1, U2, K1	Lectures
2.	Applications of machine learning to remotely sensed images - regression and classification tasks.	W1, U1, U2, K1	Workshop classes
3.	Individual student project.	U1, U2, K1	Workshop classes

Extended information/Additional elements

Teaching methods and techniques :

Discussion, Lectures

Activities	Methods of verification	Credit conditions
Lectures	Test results	The condition for passing is to obtain a positive assessment from the passing test
Workshop	Activity during classes, Execution of a project, Report, Oral answer	The condition for passing is participation in classes, performance of exercises and projects and presentation of reports and/or presentation of the results obtained

Conditions and the manner of completing each form of classes, including the rules of making retakes, as well as the conditions for admission to the exam

The basis for passing the lectures is a positive result of the passing test. The basis for passing the exercises is active participation in classes and positive results of the current checking whether the assumed learning outcomes have been achieved by the student. To pass the exercises it is necessary to complet all project tasks and present appriopriate reports or/and presentations. In the case of project tasks, the following will be evaluated: the correctness of the adopted methodology of solving the task, its final effect, the timeliness of execution and the way of presenting the results, as well as answers to questions asked by the lecturer during the presentation of results. The grade from the exercises will be the arithmetic mean of the grades from individual projects. To pass the subject, it is required to obtain positive grades (minimum 3.0) from each of the projects carried out.
The student who participated in compulsory classes (i.e. missed no more than 2 classes without excuse) is eligible for two additional approaches to pass the project or the passing test.

Method of determining the final grade

The final grade is the weighted average grade from the the passing test of lectures (30%) and grades from exercises (70%). To pass the subject, it is required to obtain positive grades (minimum 3.0) from each of the performed projects, tests and the passing test of lectures.

Manner and mode of making up for the backlog caused by a student justified absence from classes

The conditions for compensating for arrears resulting from the student's absence will be determined in an individual manner based on: the number of absences, the type of arrears and the degree of advancement of the student in the performance of his exercises. A way to compensate for the backlog may be to take exercise classes in another exercise group (after prior notification and with the consent of the lecturer) or the student's own work with the possibility of consulting it with lecturers.

Prerequisites and additional requirements

Basic knowledge of machine learning methods and techniques

Rules of participation in given classes, indicating whether student presence at the lecture is obligatory

Participation in the classes is mandatory. A maximum of 2 (in words: two) unjustified absences is allowed in the semester. The excuse for absence may be health reasons or other important reasons recognized by the instructor. The student is obliged to justify absence from the first classes after the reason for the absence has ceased. Exceeding the threshold of 20% of unjustified absence results in the inability to pass the exercises. In exceptional cases, a student who has important random causes or due to a documented, long-term illness exceeded the above-mentioned limits, can obtain the consent of the teacher to pass the exercises.

Literature

Obligatory

1. David J. Lary, Amir H. Alavi, Amir H. Gandomi, Annette L. Walker: Machine learning in geosciences and remote sensing, Geoscience Frontiers, Volume 7, Issue 1, 2016, Pages 3-10,
2. Lei Ma, Yu Liu, Xueliang Zhang, Yuanxin Ye, Gaofei Yin, Brian Alan Johnson: Deep learning in remote sensing applications: A meta-analysis and review, ISPRS Journal of Photogrammetry and Remote Sensing, Volume 152, 2019, Pages 166-177

Optional

1. Kuhn M., Johnson K.: Applied Predictive Modelling, Springer, New York, NY, 2013.

Scientific research and publications

Publications

1. Drzewiecki W.: Thorough statistical comparison of machine learning regression models and their ensembles for sub-pixel imperviousness and imperviousness change mapping, Geodesy and Cartography, 2017 vol. 66 no. 2, s. 171–209
2. Drzewiecki W. Improving sub-pixel imperviousness change prediction by ensembling heterogeneous non-linear regression models , Geodesy and Cartography, 2016 vol. 65 no. 2, s. 193–218
3. Drzewiecki W.: Comparison of selected machine learning algorithms for sub-pixel imperviousness change assessment. 2016 Baltic Geodetic Congress (Geomatics) : Gdansk, Poland 2–4 June 2016 : proceedings. S. 67–72.
4. Wojciech DRZEWIECKI, Anna Wawrzaszek, Michał Krupiński, Sebastian Aleksandrowicz, Katarzyna Bernat: Applicability of multifractal features as global characteristics of WorldView-2 panchromatic satellite images. European Journal of Remote Sensing, 2016 vol. 49, s. 809–834
5. Drzewiecki W.: Sub-pixel classification of middle-resolution satellite images – evaluation of regression trees applicability to monitor impervious surfaces coverage. Geomatics and Environmental Engineering, 2010 vol. 4 no. 4, s. 61–75

Learning outcomes prescribed to a field of study

Code	Content
GI1A_K01	ma świadomość konieczności samodoskonalenia się, a także postępowania profesjonalnego, odpowiedzialnego i zgodnego z zasadami etyki zawodowej
GI1A_K05	prawidłowo identyfikuje i rozstrzyga dylematy związane z wykonywaniem zawodu; zachowuje etyczną postawę przy wykonywaniu powierzonych zadań i prezentacji ich wyników
GI1A_U01	potrafi posługiwać się aparatem matematycznym, obejmującym algebrę liniową, analizę, geometrię analityczną, logikę, rachunek prawdopodobieństwa, statystykę, w tym metody matematyczne i metody numeryczne, niezbędne do formalnego opisu i analizy problemów algorytmicznych i ich rozwiązań
GI1A_U03	potrafi pozyskiwać, przetwarzać i integrować dane oraz automatyzować te procesy z wykorzystaniem nowoczesnych technologii
GI1A_U07	umie komunikatywnie prezentować wyniki analiz stosując raporty, grafiki, wizualizacje i metody kartograficzne
GI1A_W01	ma uporządkowaną wiedzę w zakresie matematyki, obejmującą algebrę liniową, analizę, geometrię analityczną, logikę, rachunek prawdopodobieństwa, statystykę, w tym metody matematyczne i metody numeryczne, niezbędne do formalnego opisu i analizy problemów algorytmicznych i ich rozwiązań oraz opisu i analizy działania systemów informatycznych w aspekcie oprogramowania
GI1A_W06	zna zasady i metody automatyzacji przetwarzania danych pozwalające na rozwiązywanie zagadnień geoinformatycznych i inżynierskich