# SYLLABUS OF A MODULE

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|---|---|
| Polish name of a module | **UCZENIE GŁĘBOKIE** |
| English name of a module | **DEEP LEARNING** |
| ISCED classification - Code | 0613 |
| ISCED classification - Field of study | Software and applications development and analysis |
| Languages of instruction | English |
| Level of qualification:<br>***1 – BSc (EQF 6)***<br>***2 – MSc (EQF 7)***<br>***3 – PhD (EQF 8)*** | *2* |
| Number of ECTS credit points | *4* |
| Examination:<br>***EO – exam oral***<br>***EW – exam written***<br>***A - assignment*** | *EW* |
| Available in semester:<br>***S – Spring only***<br>***A – autumn only***<br>***Y - booth*** | *A* |

## Number of hours per semester:

| Lecture | Exercises | Laboratory | Seminar | E-learning | Project |
|---|---|---|---|---|---|
| 15E | | 30 | | | |

## MODULE DESCRIPTION

### MODULE OBJECTIVES

O1. Learning advanced methods of training artificial neural networks

O2. Learning the practical aspects of training artificial neural networks

### PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of mathematical analysis and linear algebra
2. Knowledge of classical machine learning methods
3. Familiarity with basic machine learning techniques
4. Ability to program in a high-level language
5. Ability to work independently and in a team
6. Knowledge of the English language

### LEARNING OUTCOMES

LO 1 – The student has knowledge of modern methods for creating artificial neural networks and deep learning.

LO 2 – Can create models of artificial neural networks, including deep and convolutional network.

LO 3 – Can think and act in a creative and entrepreneurial manner.

**MODULE CONTENT**

| **Type of classes – lecture** | **Number of hours** |
|---|---|
| **Lec 1** - introduction to deep learning | **1** |
| **Lec 2,3** - Autoencoders | **2** |
| **Lec 4,6** - Restricted Boltzmann Machines | **2** |
| **Lec 6,7** - Deep belief networks | **2** |
| **Lec 8,9** - Generative models | **2** |
| **Lec 10,11** - Generative adversarial network | **2** |
| **Lec 12-13** - Attention mechanism in neural networks | **2** |
| **Lec 14,15** - Spiking neural networks | **2** |
| **Sum** | **15** |
| **Type of classes– laboratory.** | **Number of hours** |
| **Lab 1** - Introduction to working environment | **2** |
| **Lab 2** - Dimensions reduction with autoencoders | **2** |
| **Lab 3-4** - Denoising autoencoders | **4** |
| **Lab 5-6** - Sparse autoencoders | **4** |
| **Lab 7-8** - Variational autoencoders | **4** |
| **Lab 9-11** - Restricted Boltzmann machine | **6** |
| **Lab 12-14 -** Generative adversarial network | **6** |
| **L15** - Passing laboratory | **2** |
| **Sum** | **30** |

**TEACHING TOOLS**

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| 1. Lecture using multimedia presentations |
| 2. Preparation of reports on the implementation of the exercises |
| 3. Instructions for performing laboratory exercises |
| 4. Laboratory equipped with PC-class computers |
| 5. CuT E-learning platform |

**WAYS OF ASSESSMENT ( F – FORMATIVE, S – SUMMATIVE**

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| **F1. -** assessment of preparation for laboratory exercises |
| **F2. -** assessment of the ability to apply the acquired knowledge while doing the exercises |
| **F3. -** evaluation of reports on the implementation of exercises covered by the curriculum |
| **F4. -** assessment of activity during classes |
| **S1. -** assessment of the ability to solve posed problems and the way of presenting obtained results – Test / Oral examination / Laboratory report * |
| **S2. -** assessment of mastering the lecture material – lecture credit (exam) |

*) the condition for obtaining credit is to receive positive grades from all laboratory exercises and to carry out the verification task.

## STUDENT'S WORKLOAD

| L.p. | Forms of activity | Average number of hours required for realization of activity |
|---|---|---|
| **1.** | **Contact hours with teacher** | |
| 1.1 | Lectures | 15 |
| 1.2 | Tutorials | |
| 1.3 | Laboratory | 30 |
| 1.4 | Seminar | |
| 1.5 | Project | |
| 1.6 | Examination | 2 |
| | Total number of contact hours with teacher: | 47 |
| **2.** | **Student's individual work** | |
| 2.1 | Preparation for tutorials and tests | |
| 2.2 | Preparation for laboratory exercises, writing reports on laboratories | 20 |
| 2.3 | Preparation of project | |
| 2.4 | Preparation for final lecture assessment | |
| 2.5 | Preparation for examination | 13 |
| 2.6 | Individual study of literature | 20 |
| | Total number of hours of student's individual work: | 53 |
| | Overall student's workload: | 100 |
| **Overall number of ECTS credits for the module** | | 4 |
| Number of ECTS points that student receives in classes requiring teacher's supervision: | | 1.88 |
| Number of **ECTS** credits acquired during practical classes including laboratory exercises and projects: | | 1.2 |

## BASIC AND SUPPLEMENTARY RESOURCE MATERIALS


1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, http://www.deeplearningbook.org, 2016
2. Charu C. Aggarwal, Neural Networks and Deep Learning. A Textbook, Springer, 2018,
3. James P. Coughlih, Robert H. Baran: Neural Computation in Hopfield Networks and Boltzmann Machines, Univ of Delaware Pr 1995
4. David Foster, Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, O'reilly, 2019


## MODULE COORDINATOR ( NAME, SURNAME, E-MAIL ADDRESS)


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