



Rzeczpospolita  
Polska



NARODOWE CENTRUM NAUKI

artiQ

ARTIQ

## ARTIQ - AI Centres of Excellence

Application for a Host Institution

<b>Institution</b>	National Centre for Research and Development, National Science Centre
<b>Project Joint National Project:</b>	ARTIQ – AI Centres of Excellence
<b>Deadline for the submission of applications</b>	8th of April-11th of May 2021

### I. HOST INSTITUTION DATA

#### Identification data of the Host Institution

<b>Name (full)</b>	<i>Jagiellonian University in Cracow</i>
<b>Name (short)</b>	<i>JU</i>
<b>Name of the main organisational unit</b> (where applicable)	<i>Faculty of Mathematics and Computer Science</i>
<b>Address of the registered office</b>	
Street	Ul. Gołębia
Building No.	24
Office No.	
Postal code	31-007 Cracow
City/district	Cracow
Post office	Cracow
Municipality	Cracow
County	Cracow city
Province	Małopolska

<b>Correspondence address (if different than the address of the registered office)</b>	
Street	<i>Ul. Prof. S. Łojasiewicza</i>
Building No.	<i>6</i>
Office No.	
Postal code	<i>30-348 Cracow</i>
City/district	<i>Cracow</i>
Post office	<i>Cracow</i>
Municipality	<i>Cracow</i>
County	<i>Cracow city</i>
Province	<i>Małopolska</i>
EPUAP [Electronic Platform for Public Administration Services] mailbox	<i>/uj/CAWP</i>
<b>Legal form</b>	<i>A public university with legal personality</i>
<b>The person appointed for contact with NCBR and with the potential Leader/Project Manager</b>	
First name	<i>Marek</i>
Last name	<i>Śmieja</i>
Position	<i>assistant professor</i>
Phone number	<i>664081921</i>
E-mail address	<i>marek.smieja@uj.edu.pl</i>
<b>The person authorised to represent the applicant</b>	
First name	<i>Piotr</i>
Last name	<i>Kuśtrowski</i>
Function/Position	<i>Vice-Rector for Research</i>

## II. CAPACITY OF THE HOST INSTITUTION TO PERFORM THE PROJECT

1. Description of major research achievements in the scope of implementation of R&D projects, as well as the commercialisation of deliverables of such projects regarding artificial intelligence for the last 5 years prior to or in the year of the application along with a list of the most important publications and patents of the applicant (max. 1 A4 page).

One of the results of the projects are works published in the most prestigious conferences (A\* core rank) and journals related to artificial intelligence.

The most important publications:

- P. Spurek et al., Hypernetwork approach to generating point clouds, International Conference on Machine Learning (ICML), p. 9099-9108, 2020.
- B. Zieliński, et al., Persistence bag-of-words for topological data analysis, Proceedings of the 28<sup>th</sup> International Joint Conference on Artificial Intelligence (IJCAI), p. 4489-4495, 2019
- M. Śmieja, et al., Processing of missing data by neural networks, Advances in Neural Information Processing Systems (NeurIPS) 32, p. 2719-2729, 2018.
- D. Leśniak, I. Sieradzki, I. Podolak, Distribution-interpolation trade off in generative models, International Conference on Learning Representations (ICLR), p. 9, 2018.
- S. Jastrzebski et al., Residual Connections Encourage Iterative Inference, International Conference on Learning Representations (ICLR), 2018.
- S. Knop et al., Cramer-Wold Auto-Encoder, Journal of Machine Learning Research (JMLR) 21, 2020.
- M. Śmieja et al., SeGMA: Semi-Supervised Gaussian Mixture Autoencoder, IEEE Transactions on Neural Networks and Learning Systems, 2020.

Some of the project results were commercialized and implemented into the activities of private enterprises. Especially:

- The Asymmetric Numeral Systems (ANS) family of lossless entropy coding introduced by Dr. Jarosław Duda has become the standard used by the largest IT companies. ANS is currently implemented in compressors from companies such as Facebook, Apple, Google and Dropbox.
- The developed artificial intelligence tools for predicting machine failure are used by Reliability Solutions for predictive maintenance products.
- The image inpainting and text clustering tools were commissioned by Samsung and are now used there.

Moreover, the employees of the Faculty cooperate with the following companies: MoleculeOne, Ardigen, NVIDIA, Nokia, Huawei.

2. A list of 5 research and development projects within national and international competitions in the area of artificial intelligence and implemented within the last 5 years prior to or in the year of the application (title, manager, source of financing, amount of financing) (max. 1 A4 page).

- *Bio-inspired artificial neural networks*  
Principal investigator: Jacek Tabor  
Funded by Foundation for Polish Science, Team-Net, TEAM-NET 1/4.4/2018,  
Amount of funding: 19 701 875 PLN,  
Time period: 01.09.2019-29.03.2023
- *Deep learning in terms of a distributed system of energy-efficient mobile devices for the optimization of the machine operation process,*  
Principal investigator: Igor Podolak,  
The project was a part of European Regional Development Fund, Smart Growth Programme,  
Comissioned work for Reliability Solutions, Kraków  
Amount of funding: 172 200 PLN  
Time period: 01.01.2017-31.08.2017
- *Unsupervised spiking neural networks with analog memristive devices for edge computing*  
Principal investigator: Michał Markiewicz  
Funded by National Science Centre, CHIST-ERA 2018  
Amount of funding: 724 000 PLN  
Time period: 28.01.2020 - 27.01.2023
- *Topological Dynamics*  
Principal investigator: Mateusz Juda  
Funded by National Centre for Research and Development, Tango,  
Amount of funding: 198 750 PLN  
Time period: 12.08.2019 - 31.07.2020
- *Colonoskopy - Innovative diagnostics enabling personalization of the treatment process by developing solutions supporting colonoscopic examinations, increasing the detection of precancerous colorectal cancers with a low stage of advancement,*  
Principal investogator: Marek Zaionc  
Funded by National Centre for Research and Development, INNOMED  
Amount of funding: 5 634 315,05 PLN; (for the JU: 1 331 840 PLN)  
Time period: 1.07.2014 - 31.12.2017

3. Available research equipment, apparatus/infrastructure and intangible assets held in the context of implementation of a project regarding artificial intelligence (max. 1 A4 page).

The department has a few computational platforms (servers) that are freely available to the employment of faculty. In the following we shortly describe each one of them.

1) The KunLun 9008 V5 is a new-generation server developed by Huawei based on the Intel® Xeon® Skylake series CPUs and the latest Intel Purley platform. It is suited for Cluster Resource Management (CRM) systems and High-Performance Computing (HPC) fat nodes. It features high computing performance, large memory capacity, excellent scalability, high reliability.

2) AI and deep learning can require substantial computing performance. The solve this problem is GPU technology that offers faster obtain results. Our faculty have two platforms Nvidia DGX-1 that is a deep learning system, architected for high throughput and high interconnect bandwidth to maximize neural network training performance. The core of the system is a complex of 8 Tesla V100 GPUs connected in the hybrid cube-mesh NVLink network topology. In addition to the eight GPUs, DGX-1 includes two CPUs for boot, storage management, and deep learning framework coordination. It has an integrated NVIDIA deep learning software and frameworks such as Caffe, CNTK, MXNet, TensorFlow, Theano, and PyTorch (Torch).

3) We have also five dual-processor GPU Servers that are AI systems featuring based on the NVIDIA GPU platforms. Each one contains at least 3 cards NVIDIA RTX 2080, up to 28 cores, and 256 GB system memory.

All these research equipment are located in the server room in our department, and access to them is by a secured communications channel implemented over shared, public networks VPN.

In addition to the above equipment, our faculty also has numerous licenses for paid programs such as:

- SAS (Statistical Analysis System) is a statistical software suite developed by SAS Institute for i.a. data management, advanced analytics, multivariate analysis. The software offers AI capabilities to provide you with more intelligent, automated solutions; from machine learning to computer vision, to natural language processing (NLP), to forecasting and optimization.

- MatLab is a multi-paradigm programming language and numeric computing environment that allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. It contains tools for machine learning and deep learning (Deep Learning Toolbox).

- Wolfram Mathematica is a software system with built-in libraries for several areas of technical computing that allow symbolic computation, manipulating matrices, plotting functions and various types of data, implementation of algorithms, creation of user interfaces.

4. Facilities or incentives to establish an AI Centre of Excellence in the entity (max. 1 A4 page).

The Faculty has the Machine Learning Method Group (GMUM), which brings together employees, PhD students and students specializing in artificial intelligence (<https://gmum.net/>). The group publishes their works at prestigious conferences (NeurIPS, ICML, ICLR, IJCAI), and has numerous research grants (NCN, FNP, NCBiR). In addition, the group has established cooperation with the economic environment (Ardigen, MoleculeOne, Nokia) and leading companies related to advanced technologies (DeepMind, Samsung, NVidia, Huawei). The group organizes scientific conferences (TFML, 2015, 2017, 2019) and summer schools (EEML 2020), which makes it recognizable in the country and abroad. The experience and openness to cooperation of GMUM members may facilitate the target AI Center of Excellence.

The Faculty has a computer science specialization in machine learning, which is selected annually by about 40 students. There is a doctoral school in computer science, and from the next year also in technical computer science and telecommunications. Currently, 24 PhD students specialize in machine learning. Both students and doctoral students constitute well-qualified staff for cooperation.

The Faculty of Mathematics and Computer Science is located in a modern building (built in 2008, with an area of 19,551 m<sup>2</sup>) on the new campus of the Jagiellonian University. The building has a large library, many lecture halls and laboratories equipped with projectors. The building is located about 4 km from the historic center of Krakow and 13 km from the airport. There are also other faculties in the vicinity, including the Faculty of Chemistry and the Faculty of Physics. The head of the AI Center of Excellence will receive a one-person office in the Faculty building, and the remaining associates will receive maximum 2-person offices.

The Jagiellonian University organizes administrative support, which includes:

- Technology Transfer Center (CITTRU) - responsible for comprehensive cooperation between science and the economic environment.
- The Administrative Project Support Center (CAWP). Works: supporting scientists in the preparation and implementation of projects financed from external sources, in particular from structural funds, European Commission programs, national and foreign research, research and development, education and investment programs.
- Welcome Center: provides assistance in all practical and formal matters related to coming to Poland and employing foreigners in Poland.

5. Other information concerning internationalisation of the entity, foreign scientists employed in this institution, availability of seminars in English, etc. (max. 1 A4 page).

The university is a member of a network associating renowned European universities: the Una Europa network, which is made up of 8 universities, and The Guild, which includes 19 universities, or the Coimbra Group, which associates 41 universities. Within these networks, joint research projects, staff and student exchange programs are carried out. One of the five priority thematic areas of cooperation is the area of Data Science and Artificial Intelligence. Staff internationalization rate as of December 31, 2018 (generated automatically on the basis of data from the POL-on system): 2.97.

The Faculty of Mathematics and Computer Science works closely with many foreign research institutions and offers courses in both Polish and English. Currently, 10 foreign scientists are employed at the Faculty. Moreover, 12 employees of the Faculty obtained a doctorate in a foreign unit, another 4 obtained the academic degree of habilitated doctor abroad. All seminars at the Faculty are conducted in English by default, unless all participants accept Polish. There are 6 seminars thematically related to artificial intelligence at the Faculty.

The GMUM Group cooperates with many foreign institutions:

- University of Edinburgh, Great Britain (Amos Storkey)
- New York University School of Medicine, United States (Krzysztof Geras)
- Université de Montréal, Canada (Yoshua Bengio)
- Universidade de Lisboa, Portugal (Mario A. T. Figueiredo)
- DeepMind, UK (Razvan Pascanu)
- St. Pölten UAS, Austria (Matthias Zeppelzauer)
- Know-Center GmbH, Austria (Bernhard C. Geiger, Roman Kern)

As part of the cooperation, publications are created, scientific trips and seminars are organized.

International cooperation as part of the research and research and development projects carried out at the Faculty proceeds in several ways. Main directions of the Faculty's internationalization: realization of projects dedicated strictly to international cooperation (e.g. projects financed by NAWA, the European Commission, including ERC and H2020-MSCA-RISE-2018, NCN); realization of projects in which international cooperation is based on the involvement of foreigners; presentation and confrontation of the results of research in the international arena, hence the publication of works in international publications and presentation of research results at international conferences. Evidence of the international cooperation between the scientists of the faculty and the world's leaders are works written in recent years together with mathematicians, physicists and computer scientists from leading (according to rankings) universities in the world, such as Princeton, Paris 6, Texas A&M, Georgia Institute of Technology and many more. In 2018, out of 128 publications (articles in journals from the JCR list) of employees and doctoral students of Faculty 69, were created in cooperation with foreign scientists (foreign scientists are co-authors of the publications).

6. Other significant information confirming the experience and resources of the institution (max. 1 A4 page).

In addition to the previously mentioned research directions, the GMUM group also conducts interdisciplinary research in the field of chemistry, biology and neurocognitive science with research centers and companies. In particular, cooperation with:

- a cheminformatics group of the Institute of Pharmacology of the Polish Academy of Sciences led by prof. A. Bojarski;
- MoleculeOne in the field of computer design of chemical compounds;
- Ardigen and DiCellA in the field of medical photo analysis;
- JCET research institute in the field of drug research with endothelial activity;
- a group of neurobiologists from the Nencki Institute of the Polish Academy of Sciences in Warsaw headed by prof. D. Wójcik.

The Faculty actively participates in the strategic program "Excellence Initiative - Research University" implemented in the years 2020-2025. One of the seven priority research areas is the DigiWorld area ([digiworld.id.uj.edu.pl](https://digiworld.id.uj.edu.pl); annual budget of approx. PLN 5 million) related to artificial intelligence. The main goal of DigiWorld is to strengthen the research groups of the Jagiellonian University in the field of creating, applying and researching digital technologies. Among the activities increasing the research, implementation and educational potential related to the development and application of AI are, among others:

- Purchase of specialized scientific equipment for the purposes of AI development;
- Internal competitions for mini-grants for employees, PhD students and students;
- Employing outstanding research, research and teaching staff;
- Co-financing of Research-to-Research and Research-to-Business activities;
- Co-financing internships and trips abroad, organization of conferences and visiting professors;
- Establishing 20 laboratories (<https://digiworld.id.uj.edu.pl/prelab>) that will integrate various aspects of research on artificial intelligence.

The Faculty has relevant experience in the implementation of research and research and development projects. In 2021 (as of March 31, 2021), 67 projects are being implemented, financed from external sources, including two under Horizon 2020.

Moreover, the Jagiellonian University received the HR Excellence in Research logo awarded by the European Commission. The implemented strategy is aimed at increasing the attractiveness of the working conditions of scientists. These activities are to contribute to the increase in the number of research workers in European institutions.