



Rzeczpospolita
Polska



NARODOWE CENTRUM NAUKI

artiQ

ARTIQ

ARTIQ - AI Centres of Excellence

Application for a Host Institution

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

I. HOST INSTITUTION DATA

Identification data of the Host Institution

Name (full)	University of Wrocław
Name (short)	UWr
Name of the main organisational unit (where applicable)	Faculty of Mathematics and Computer Science
Address of the registered office	
Street	Pl. Uniwersytecki
Building No.	1
Office No.	
Postal code	50-137
City/district	Wrocław
Post office	Wrocław
Municipality	Wrocław
County	Poland
Province	Lower Silesia

Correspondence address (if different than the address of the registered office)	
Street	
Building No.	
Office No.	
Postal code	
City/district	
Post office	
Municipality	
County	
Province	
EPUAP [Electronic Platform for Public Administration Services] mailbox	/UWr/SkrytkaESP
Legal form	Public University
The person appointed for contact with NCBR and with the potential Leader/Project Manager	
First name	Jan
Last name	Chorowski
Position	Professor
Phone number	71 375 78 08
E-mail address	jan.chorowski@uwr.edu.pl
The person authorised to represent the applicant	
First name	Przemysław
Last name	Wiszewski
Function/Position	Rector

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 (max. 1 A4 page).

The University of Wrocław actively researches topics in artificial intelligence, machine learning, statistics and big data algorithms.

Development and application of deep learning for speech and natural language processing

Dr hab. Jan Chorowski introduced [1] and developed attention-based speech recognition deep neural networks. These networks are readily used in industry (e.g. Google) and investigated by other research centers. Currently, Dr. Chorowski is researching the possibilities of unsupervised learning of neural networks on speech. *Dr Paweł Rychlikowski* commercially implemented speech processing systems in cooperation with Wrocław companies, and conducted R&D works in scientific and industrial consortia (including under the "Audioscope" grant listed below).

Development of statistical learning methods and simulation of stochastic processes

Prof. Małgorzata Bogdan proposed and tested effective methods of selecting features in the linear regression model: the SLOPE method [2] and the mBIC method. Both methods and their variants enjoy great interest and were successfully used, among others, to identify genetic markers important in the identification of diseases, and in financial mathematics to choose an investment portfolio. Weijie Su and Emmanuel J. Candès proved that the SLOPE method is asymptotically optimal in a much wider range than the popular LASSO method, and its introduction by prof. Małgorzata Bogdan has led to significant developments in convex optimization methods.

Dr hab. Paweł Lorek conducts research combining statistics with cryptography. He developed tests of randomness generators [3], encryption systems resistant to attacks using additional information and hard-to-reverse functions that require a lot of memory that can be used in blockchain systems.

The development of Big Data processing algorithms

Dr. Przemysław Uznański studies the algorithms for processing large data given in the form of graphs. Dr. Uznański significantly improved the complexity of the problem of batch processing the answer to *Lowest Common Ancestor* in directed acyclic graphs [4], solving the open since 13 years problem of the existence of an algorithm faster than $O(n^{2.5})$. Moreover, Dr. Uznański showed the equivalence between the classes of batch processing problems parameterized by the cost function for whole *classes of the cost function*, which generalizes the previous results in the field of *fine grained complexity*. Dr. Uznański also conducted research on the stream estimation of collection sizes and counting pattern-to-text matches.

Dr. Marek Adamczyk developed approximation algorithms for association problems operating under conditions of uncertainty. They are used in adjusting, for example, user profiles of dating applications, drivers and rides, or tasks and machines performing them [5].

Application of machine learning and evolutionary optimization methods in financial systems

Dr. Piotr Wnuk-Lipiński develops data mining and machine learning algorithms for data analysis financial ultra-high frequency, including the London Stock Exchange Limit Order Book (LSE ROB) [6].

[1] J. Chorowski, D. Bahdanau, D. Serdyuk, K. Cho, and Y. Bengio. Attention-Based Models for Speech Recognition. NIPS 2014

[2] SLOPE—adaptive variable selection via convex optimization, M Bogdan, E Van Den Berg, C Sabatti, W Su, EJ Candès, The annals of applied statistics 9 (3), 1103, (2015)

[3] Lorek, P., Łoś, G., Gotfryd, K., Zagórski, F. On testing pseudorandom generators via statistical tests based on the arcsine law, Journal of Computational and Applied Mathematics, vol 380, 2020, 112968, <https://doi.org/10.1016/j.cam.2020.112968>

[4] Fabrizio Grandoni, Giuseppe F. Italiano, Aleksander Łukasiewicz, Nikos Parotsidis, Przemysław Uznański:

All-Pairs LCA in DAGs: Breaking through the $O(n^{2.5})$ barrier. SODA 2021

[5] M Adamczyk, M Włodarczyk, Random order contention resolution schemes, 2018 IEEE 59th Annual Symposium on Foundations of Computer Science (FOCS)

[6] Anthony Brabazon, Piotr Lipinski, Philip Hamill, Characterising order book evolution using self-organising maps, Evolutionary Intelligence, vol.9, no.4, Springer, 2016, pp.167-179.

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).

Speech Processing and Deep Learning projects

1. "Discovering hidden structure of data from observations", dr hab. Jan Chorowski, NCN Opus 18, project value 1 399 080,00 PLN
2. "Audioscope - a system for automatic search of content in Polish-language recordings using a hybrid method." Consortium of University of Wrocław, Wrocław University of Science and Technology and Neurosoft, co-PI from UWr: dr Paweł Rychlikowski, project value: 1 642 873,00 PLN

Projects on algorithmic aspects of Big Data

3. "Algebraic techniques for parallelizing algorithms", dr Przemysław Uznański, NCN OPUS 2019/33/B/ST6/00298, project value 618 240,00 PLN

Projects concerning learning, inference and statistics

4. Model selection for multivariate data using the SLOPE method - theoretical properties and applications.. Opus 12, Małgorzata Bogdan, 542 150,00 PLN 2017-2020
5. "Cryptographic schemes and fast-convergent Markov chains", dr hab. Paweł Lorek, NCN Sonata Bis, project nr DEC-2013/10/E/ST/100359, 13.06.2014 -- 12.12.2017 Consortium of University of Wrocław and Wrocław University of Science and Technology. Co-PI at UWr: dr hab Paweł Lorek. PI: dr Filip Zagórski

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 Faculty of Mathematics and Computer Science has a small computing cluster for deep learning (30 GPGPU cards, including 2 RTX 3090 and 14 RTX 3080). The University has moreover access to Polish and European academic high performance computing environments.

The Faculty has the necessary data sets to conduct research on language and speech processing. The faculty also has screenshots of the London Stock Exchange Limit Order Book (LSE ROB).

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

Available guest rooms at Faculty of Mathematics and Computer Science.

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 employees of the University of Wrocław maintain working contacts with other scientists, including from Stanford, John Hopkins and Purdue Universities in the USA, the University of Montreal in Canada (MILA Laboratory) and the École Polytechnique in Paris, France. Joint research workshops are organized (e.g. JSALT 2019 Workshop <https://www.clsp.jhu.edu/workshops/19-workshop/> in which researchers from John Hopkins, MIT, INRIA-LIMSI and UWr participated)

The Faculty of Mathematics and Computer Science hosts several international students and postdocs. English-language seminars are regularly organized on machine learning and statistics (e.g. <https://statistical-learning-seminars.github.io/>).

The University of Wrocław is a partner of the CASUS research center (<https://www.casus.science/>) in Goerlitz dealing with modeling of complex systems with the use of artificial intelligence tools.

The Faculty of Mathematics and Informatics of the University of Wrocław provides a "Data Science" master programme taught fully in English (<http://www.datascience.uni.wroc.pl/>) where foreign students study.

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

University of Wrocław employees willingly cooperate and implement projects with innovative companies, including Nokia Artificial Intelligence Lab, Tooploox, MicroscopeIT, Neurosoft, NavAlgo, InferMedica, Capgemini.