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)	***Wroclaw University of Science and Technology***
Name (short)	***WUST***
Name of the main organisational unit (where applicable)	***faculty***
Address of the registered office	
Street	Wyb. Wyspianskiego
Building No.	*27*
Office No.	*N/A*
Postal code	*50-370*
City/district	*Wroclaw*
Post office	*Wroclaw*
Municipality	*Wroclaw*
County	*Wroclaw*
Province	*dolnoslaskie*

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	***/PolitechnikaWroclaw/SkrytkaESP***
Legal form	***Higher education institution***
The person appointed for contact with NCBR and with the potential Leader/Project Manager	
First name	***Dariusz***
Last name	***Król***
Position	***Professor***
Phone number	***+ 48 511 297 426***
E-mail address	***dariusz.krol@pwr.edu.pl***
The person authorised to represent the applicant	
First name	***Dariusz***
Last name	***Lydzba***
Function/Position	***Vice-Rector for Cooperation***

II. CAPACITY OF THE HOST INSTITUTION TO PERFORM THE PROJECT

Wrocław University of Science and Technology

1. DESCRIPTION OF MAJOR RESEARCH ACHIEVEMENTS IN THE SCOPE OF IMPLEMENTATION OF R&D PROJECTS REGARDING ARTIFICIAL INTELLIGENCE FOR THE LAST 5 YEARS ALONG WITH A LIST OF THE MOST IMPORTANT PUBLICATIONS

The most important research achievements of Wrocław University of Science and Technology in the field of R&D projects as well as commercialization of their results regarding artificial intelligence are:

- **development and implementation of machine learning tools for tasks such as drug design and advanced analysis of NMR spectra**; accomplished under the project POIR.01.01.01-00-1083/15 in cooperation with Indata Software S.A.; published inter alia in: Klukowski P. et al., NMRNet: a deep learning approach to automated peak picking of protein NMR spectra. Bioinformatics. 2018 Aug 1;34(15):2590-2597. https://doi.org/10.1093/bioinformatics/bty134
- **development of automated production planning tools based on bio-inspired metaheuristics**; accomplished under the contract agreement with Toyota Motor Manufacturing Europe, published inter alia in: Bożejko W. et al., Neuro-tabu search approach to scheduling in automotive manufacturing, Neurocomputing (2021), in press, https://doi.org/10.1016/j.neucom.2020.01.121
- **development of an automated, IoT-based monitoring system designed to monitor the health of dairy cows**; accomplished under the project POIR.02.03.02-02-0009/17 in cooperation with CORP For Farm Animals; published inter alia in: Unold O. et al., IoT-Based Cow Health Monitoring System. In: Krzhizhanovskaya V. et al. (eds) Computational Science – ICCS 2020. ICCS 2020. LNCS, vol 12141. Springer, Cham. https://doi.org/10.1007/978-3-030-50426-7_26
- **development of the Production Unit Performance Management Tool, a monitoring and diagnostic tool to select basic signals that have a significant impact on output KPIs**; accomplished under the project POIR.01.01.01-00-0687/17-00; published inter alia in: Król D. et al., Development of a Decision Support Tool for Intelligent Manufacturing using Classification and Correlation Analysis, 2019 IEEE International Conference on Systems, Man and Cybernetics (SMC), 2019, pp. 88-94, https://doi.org/10.1109/SMC.2019.8914222
- **analysis of the current state of knowledge in detecting fake news**; accomplished within the SocialTruth project under the EU Horizon 2020 Research and Innovation Programme; published inter alia in: Choraś M. et al., Advanced Machine Learning techniques for fake news (online disinformation) detection: A systematic mapping study, Applied Soft Computing, 101, 2021, https://doi.org/10.1016/j.asoc.2020.107050
- **setting up and development of the CLARIN-PL, Common Language Resources and Technology Infrastructure** (http://clarin-pl.eu), including the development of a bilingual lexical and semantic network plWordNet (http://plwordnet.pwr.edu.pl) with over a thousand registered users; enabling the improvement of search quality in online stores, grouping of products in e-commerce, generating texts for SEO purposes, text analysis from recognized speech, tracking digital footprint, text sentiment analysis, building knowledge graphs, integrated text mining; published inter alia in: Bartusiak R., et al., WordNet2Vec: Corpora agnostic word vectorization method, Neurocomputing, 326-327, 2019, 141-150, https://doi.org/10.1016/j.neucom.2017.01.121
- **analysis of emotions in the brain-expanded WordNet** - a model for recognizing 10 dimensions of emotions, learned from data containing over 18 million emotive annotations, resulting from the work of 20,000 people; the results have been implemented at Sentimenti (https://sentimenti.com) and Sentistocks (https://sentistocks.com); published inter alia in: Kocoń J. et al., Mapping WordNet onto human brain connectome in emotion processing and semantic similarity recognition, Information Processing & Management, Volume 58, Issue 3, 2021, https://doi.org/10.1016/j.ipm.2021.102530
- **development of open-source Dru platform for monitoring and doing research on blockchain** funded by the Zcash Foundation (USA); the results were made available in the public domain under an open-source license https://dru.readthedocs.io/en/master/ and published inter alia in: Michalski R. et al., Dru: Studying Blockchain as a Complex Network, 2020 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM), 2020, pp. 929-932, https://doi.org/10.1109/ASONAM49781.2020.9381469

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2. A LIST OF 5 RESEARCH AND DEVELOPMENT PROJECTS WITHIN NATIONAL AND INTERNATIONAL COMPETITIONS IN THE AREA OF ARTIFICIAL INTELLIGENCE

Id	Title	Manager (R&D)	Source of financing	Amount of financing
1.	Intelligent Platform supporting the production and maintenance of Internet of Things and Services systems using intelligent computing methods, VII LIDER programme 0177/L-7/2015	Dr. Paweł Świątek	National Centre for Research and Development	1 183 500 PLN
2.	System for lameness detection in dairy cow mobility combining gait features and a strain gauge platform using artificial intelligence, POIR.01.01.01-00-2248/20	Dr. Maciej Nikodem	National Centre for Research and Development	3 996 135,17 PLN
3.	HAPADS: Highly Accurate and Autonomous Programmable Platform for Providing Air Pollution Data Services to Drivers and the Public, NOR/POLNOR/HAPADS/0049/2019-00 (https://hapads.eu/)	Dr. Krystian Wojtkiewicz	National Centre for Research and Development (Norway grants)t	984 161,25 PLN
4.	Lifelong Machine Learning on Data Stream	Prof. Dr. Michał Woźniak	National Science Centre (CEUS-UNISONO)	354 121,96 EUR
5.	CLARIN - Common Language Resources and Technology Infrastructure, POIR.04.02.00-00C002/19 (https://clarin.biz)	Prof. Dr. Maciej Piasecki	National Centre for Research and Development	105 066 667 PLN

3. AVAILABLE RESEARCH EQUIPMENT, APPARATUS/INFRASTRUCTURE AND INTANGIBLE ASSETS HELD IN THE CONTEXT OF IMPLEMENTATION OF A PROJECT REGARDING ARTIFICIAL INTELLIGENCE

Wrocław University of Science and Technology, through the Wrocław Centre for Networking and Supercomputing (https://www.wcss.pl/en/) provides the following computing resources for the AI Centre of Excellence:

- **Cluster Bem** - supercomputer on the TOP500 listed at the beginning of the second hundred (as of November 2020), with 36 thousand computing cores with a total power of ~3.1 PFlop/s. The cluster has 1,300 computing nodes implemented over InfiniBand with the number of cores from 24 to 96. Some of the nodes are equipped with GPU accelerators.
- **Campus cluster** - a cluster that provides application services on demand. The cluster has 48 nodes, including 16 with NVIDIA Quadro FX 580 cards.

On high-power computers, you can compute, among others, data analysis, mathematical, statistical and engineering calculations, and visualization of calculations. For this purpose, you can use the standard system and tool software as well as scientific software, e.g. Abaqus · ABINIT · ADF · Amber · ANSYS · AutoDock · BAGEL · Beast · Biovia · Cfour · Comsol · CP2K · CPMD · CRYSTAL09 · Dalton · Dask · DIRAC · FDS-SMV · GAMESS · Gaussian · Gromacs · IDL · Lumerical · Mathcad · Mathematica· Matlab · Molcas · Molden · Molpro · MOPAC · NAMDFOc NBM · Open NAMC NBM · NAMDFOc NBM · Orca · Quantum ESPRESSO · R · Rosetta · SIESTA · Tinker · TURBOMOLE · VASP · VMD · WIEN2k. Access to IBM and D-Wawe quantum computers is also planned.

Moreover, the Centre will be able to use the resources of three specialized research labs and facilities.

1. **Laboratory of service and network technologies** (https://kinf.pwr.edu.pl/badania/pracownie-i-laboratoria/) - the lab consists of two cabinets equipped with 3 operator class switches for Juniper converged networks, private cloud computing with GPU virtualization, six RACK servers and hardware disk arrays, a total of over 400 physical CPU cores, approx. 3TB of RAM and over 80TB of disk space. The lab is equipped with devices for deep packet inspection as well as IDS and IPS, network traffic analyzers, as well as programmable switches for SDN, ICN and CAN networks, including Pica8, NetFPGA, EZappliance. It is connected to the PIONIER network by three 10Gb links each and to the European GEANT network with a 10Gb link. There is a PL-LAB node designed to conduct research in the field of the Internet of the Future, including 5G, SDN, CAN and ICN networks, as well as ML, Internet of Things, multimedia and cloud services.
2. **Laboratory of vision systems and production quality monitoring** (https://kam.pwr.edu.pl/laboratoria/laboratorium-systemow-wizyjnych-i-monitorowania-jakosci-produkcji) - a lab in the field of production quality monitoring using industrial cameras. It is equipped with industrial cameras used to monitor the quality of production: from infrared cameras, through cameras operating in visible light, to UV cameras, a 3D camera, a high-speed camera and a laser interferometer. The lab allows to simulate defects in continuous and discrete production, laser metal heating, heat exchanger and a vision security system in the building.
3. **The CLARIN-PL language technology research infrastructure** (http://clarin-pl.eu) includes: (a) a computing cluster - 130 hardware threads and 19 TB of RAM, intended for building models, and a GPU card system with a power of 240 TFlop/s and 120 GB of RAM, intended for building models of deep networks. CLARIN-PL includes dozens of language resources, language tools and research applications based on language technology, and also provides an efficient, distributed, parallel system for running configurable language data processing pipelines, which automatically scales proportionately to the load of processing requests, (b) language resources (https://clarin-pl.eu/index.php/zasoby/), (c) language tools and applications (https://clarin-pl.eu/index.php/uslugi/), (d) CLARIN-PL repository (https://clarin-pl.eu/dspace/), (e) direct access to web services (http://ws.clarin-pl.eu/), (f) user manuals and training materials (https://clarin-pl.eu/index.php/mediateka/).

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4. FACILITIES OR INCENTIVES TO ESTABLISH AN AI CENTRE OF EXCELLENCE IN THE ENTITY

Wrocław University of Science and Technology is one of the leading AI research centers in Central and Eastern Europe. For many years, scientific research covering various aspects of AI has been conducted here, and the results from this center are published in the best scientific journals and presented at prestigious conferences. The university employs outstanding scientists and brave innovators developing startups based on the best AI solutions. Due to the relatively low operating costs and easy access to a large number of engineers, researchers and students from the AI area, Wrocław University of Science and Technology is an ideal place to develop innovative business initiatives.

As part of the AI Centre of Excellence, interdisciplinary and cross-sectoral, cross-border and international research will be carried out on the use of artificial intelligence, primarily in engineering and technology, but also in medical, social and exact sciences, in order to support the absorption of innovative solutions by the economy and society. The extensive experience with this type of research so far gives us optimism and creates a real chance for their implementation. The mission of the Centre covers the areas defined in the European Union's research and Horizon Europe Research and Innovation Programme (2021-2027), which covers key areas such as energy, transport, biodiversity, health, food and a closed loop production. These areas are waiting for the development of AI.

A person holding the position of the Leader of the AI Centre of Excellence as part of our hosting organization will be able to cooperate with scientists conducting research at world level, start innovative research projects carried out by students and doctoral students of Wrocław University of Technology, define the directions of development at the Centre, having the funds to build a R&D center on European level. A friendly environment for business initiatives created by both the city of Wrocław and dedicated university units, including the Academic Entrepreneurship Incubator, the Centre for Knowledge and Scientific Information and the Wrocław Centre for Technology Transfer, will allow the research results to be transformed into thriving startups with a high level of innovation, which can compete with companies established in the Silicon Valley. The Wrocław Centre for Networking and Supercomputing will provide priority access to computing resources and services (as described in Sec. II.3).

A university-owned SPV dedicated to the AI Excellence Centre will be established. The financial stability of the new company will be ensured by granting a subsidy for statutory activities, which will be supplemented with income from commercial activities or by equipping the company with fixed assets or intangible assets (e.g. patents), which will be a source of additional income from commercialization.

Wrocław University of Science and Technology will cover scholarships from its own fund for three PhD students admitted to the Doctoral School with research topics predefined in the Centre. In addition, the team of the Centre will be supported by secondment opportunities from six departments: Department of Control Systems and Mechatronics, Department of Computer Engineering, Department of Computer Systems and Networks, Department of Computer Science and Systems Engineering, Department of Applied Informatics and Department of Computational Intelligence. The access to the best students will be provided as part of a research and implementation project or team project course by courtesy of our teaching staff.

Finally, although it is not a key issue in this case, the Rector of Wrocław University of Science and Technology has declared for the Leader a free permit for a car park space at the campus, which is usually a big problem.

5. OTHER INFORMATION CONCERNING INTERNATIONALISATION OF THE ENTITY

Wrocław University of Science and Technology has been one of the largest and best universities in Poland for many years. In the national ranking of Perspektywy 2020, in the group of technical universities, it ranks 3rd. However, in the international QS University Rankings EECA 2021 ranking, it ranks 46th among 400 universities in Europe and Central Asia. Such a high position is achieved due to a significant number of about 1,200 foreign students. Over the last three years, cooperation has been established with 123 academic institutions in Europe, and the number of international publications has exceeded 30% of all scientific publications. In 2016, the European Commission awarded the Wrocław University of Technology with the prestigious logo "HR Excellence in Research". It is awarded to institutions that apply the principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers.

The high scientific position of the departments making up the AI Centre of Excellence is demonstrated, among others, by the fact that as many as 4 our professors were included in the prestigious ranking of the most influential people of science in the world. The TOP 2% list contains the names of scientists whose publications are most often cited by others. Departments conduct international cooperation on the basis of bilateral agreements on cooperation and exchange of students, agreements on double diploma and academic mobility agreements in the Erasmus+ program. One of the significant results are double diplomas of completing Master studies, e.g. with the Blekinge Institute of Technology. The educational offer of our departments includes 3 fields of study fully conducted in English. Since 2017, Wrocław University of Science and Technology has actively participated in the activities of the European Research Center for Information Systems (ERCIS), a network of over twenty leading universities in the field of information systems. One of the results of our cooperation was a Polish-German research project entitled "Deep recommendation based on collective knowledge" under the Executive Program with the German Academic Exchange Service. In 2021, a meeting of the ERCIS consortium will be held in Wrocław. One of the leading topics will be Industry-Academic AI Partnerships.

As part of research projects carried out, Wrocław University of Science and Technology has employed many foreign scientists in the last 5 years. In this group, we can distinguish 9 experts of artificial intelligence: (1) Prof. Nitesh Chawla, University of Notre Dame, (2) Prof. Boleslaw Szymanski, Rensselaer Polytechnic Institute, (3) Prof. Reda Alhajj, University of Calgary, (4) Prof. Arunabha Sen, Arizona State University, (5) Prof. Manuel Maria Grana Romay, Universidad del Pais Vasco, (6) Prof. Omar Lizardo, University of Notre Dame, (7) Dr. Alexandre Manhaes Savio, University of the Basque Country, (8) Dr. Jose Antonio Saez Munoz, University of Granada, (9) Dr. Cezary Sieluzycki , Pierre and Marie Curie University, Paris.

Wrocław University of Science and Technology co-organizes regular international scientific conferences covering various aspects of artificial intelligence: (1) Asian Conference on Intelligent Information and Database Systems (https://aciids.pwr.edu.pl/2021/), (2) International Conference on Computational Collective Intelligence (https://iccci.pwr.edu.pl/2021/), (3) International Conference on Dependability of Computer Systems (http://depcos.pwr.edu.pl/), (4) International Conference on Computer Recognition Systems (http://cores.pwr.wroc.pl/) and (5) International Conference on Multimedia & Network Information Systems (https://missi.pwr.edu.pl/2022/). In May 2021, the first two conferences (1) and (2) achieved a high B category in the CORE ranking. Based on Springer reports, the papers have been downloaded well nearly 4 million times.

As part of a successful cooperation with the Wrocław University of Economics and the Gdynia Maritime University, the seminar “Collective Intelligence in Information Systems” has been organized for over four years. The following list includes only some of the invited speakers from abroad, among others Prof. Jan Treur, Vrije Universiteit Amsterdam, Prof. Bogdan Franczyk, University of Leipzig, Prof. Eunika Mercier-Laurent, University of Reims Champagne Ardennes, Dr. Denis Martins and Dr. Leschek Homann, University of Münster, Adane Nega Tarekegn, University of Turin, Prof. Gottfried Vossen, University of Münster, Prof. Dalia Kriksciuniene, Vilnius University, Prof. Keun Ho Ryu, Chungbuk National University.

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Wrocław University of Science and Technology

6. OTHER SIGNIFICANT INFORMATION CONFIRMING THE EXPERIENCE AND RESOURCES OF THE INSTITUTION

The Scientific Council of the AI Centre of Excellence is a collective body, the principal aim of which is the supervision over the scientific activities providing an advisory opinion or comment. The Council consist of 7 members, including the Leader and representatives of the departments that make up the Centre. They are experienced and recognized scientists: Prof. Dr. Wojciech Bożejko (Department of Control Systems and Mechatronics), Prof. Dr. Olgierd Unold (Department of Computer Engineering), Prof. Dr. Michał Woźniak (Department of Computer Systems and Networks), Dr. Maciej Zięba (Department of Computer Science and Systems Engineering), Prof. Dr. Dariusz Król (Department of Applied Informatics) and Prof. Dr. Przemysław Kazienko (Department of Computational Intelligence).

The research carried out at the Centre will include: machine learning, methods of improving the quality of weak classifiers, complex and hybrid methods of object recognition, information fusion and combined classifiers, stream data classification and the detection of changes in the classification model parameters, single-class classification, unbalanced data analysis, active learning , construction of effective algorithms for strongly NP-difficult discrete optimization problems, the use of algorithms for scheduling and optimization problems in production and logistics systems, grammatical inference, evolutionary algorithms, learning classification systems, fuzzy rule systems, DNA computing, natural language processing, deep learning, sentiment analysis, knowledge engineering methods, data quality assessment methods, cognitive techniques, applications of intelligent methods for practical problems.

An important confirmation of the research and teaching potential of our Institution is the launch of new fields of study: "Artificial Intelligence", "Cybersecurity" and "Trusted Systems of Artificial Intelligence". The studies cover issues of machine learning methods, including probabilistic and deep models, the use of artificial intelligence in personalized recommendation systems and in the processing of natural language, multimedia data, network data and data from digital media. The graduates are prepared to use intelligent optimization techniques in computer forensics, create secure services for intelligent ICT systems, design and apply advanced machine learning methods, including deep learning, to extract knowledge from mass data, using high-performance cloud systems and supercomputing systems. During their studies, we direct students to one of three paths of further development: (1) undertake postgraduate research (PhD), (2) work in the top R&D centers worldwide (Google, Facebook, Microsoft, Samsung) or (3) launch your own startup.

Our university is an active participant in many AI initiatives, incl. Academy of Innovative Applications of Digital Technologies (AI Tech), Working Group for IoT at the Ministry of Digital Affairs and Ministry of Entrepreneurship and Technology, Future Industry Platform, Polish Alliance for the Development of Artificial Intelligence (PP-RAI). It is also a member of the Polish Special Interest Group on Machine Learning (PL SIGML), the Polish Chapter of the IEEE Systems, Man, and Cybernetics Society (IEEE SMC) and the Poland Section of the IEEE Computational Intelligence Society (IEEE CIS).

The best confirmation of the Institution's experience and capabilities for artificial intelligence development are bibliometric and financial references. The number of scientific publications for 2020 alone is 490, with the total IF exceeding 450. More than 50% of these figures concern publications in the field of artificial intelligence. It is even clearer when summing up the amounts of funding in currently working research projects. The expected co-financing of these projects, limited to this year in the group of departments forming the Centre, will exceed PLN 5 million.

More information about the AI Centre of Excellence in the Wrocław University of Science and Technology can be found at ai.pwr.edu.pl.