


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)	***AGH University of Science and Technology***
Name (short)	***AGH UST***
Name of the main organisational unit (where applicable)	
Address of the registered office	
Street	*al. Mickiewicza*
Building No.	*30*
Office No.	
Postal code	*30-059*
City/district	*Kraków*
Post office	*Kraków*
Municipality	*m. Kraków*
County	
Province	*Małopolska*
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	***/AGH/COP***
Legal form	***legal entity***
The person appointed for contact with NCBR and with the potential Leader/Project Manager	
First name	***Joanna***
Last name	***Jaworek-Korjakowska, PhD, DSc.***
Position	***Professor*** **Deputy Head of the Department of Automatic Control and Robotics,** **Faculty of Electrical Engineering, Automatics, Computer Science and Biomedical Engineering, AGH-UST**
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The person authorised to represent the applicant	
First name	***Professor Rafał***
Last name	***Wiśniowski***
Function/Position	***Vice-Rector for Cooperation***

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).

Artificial Intelligence research conducted at AGH-UST includes development of AI technologies (architectures, methods, algorithms and models) in machine vision, medical applications, robotics and control, privacy and data security, autonomous driving, material science, and others. Most important research achievements – outlined below – are only a snapshot of our accomplishments in research, development and commercialisation of AI technologies. According to the report "Policy for the Development of Artificial Intelligence in Poland from 2020" (Annex C, p. 56) AGH-UST has the largest number of publications in AI among Polish universities.

AI for national security and public safety. Since 2006 AGH carries out research projects focused on development of novel solutions for national security and public safety. This includes applications of AI methods in support of criminal investigations and law enforcement activities. The most important outcome of these research efforts is the **LINK2** system developed in a series of R&D projects financed by NCBR, including "A system for gathering and generating information for criminal analysis and coordination of Border Guard activities" (2015-2018) and "Processing and analysis of mass data related to economic crimes" (2018-2021). LINK2 supports analysis of complex graph data, e.g. connections in organized crime. It is available to authorized governmental agencies and is being constantly developed, ultimately replacing commercial solutions, such as I2 Analyst Notebook. More than 100 license agreements have been signed in recent years and the number of active users is in several thousands. Furthermore, due to interest from foreign government agencies, selected versions of LINK2 were translated to English, Russian and Ukrainian languages. With funding from European Union and in cooperation with Polish National Police, a license agreement was signed with the Moldavian police.

AI in transportation safety. AGH executed numerous projects devoted to applications of artificial intelligence in driving safety and autonomous driving. An important outcome of these efforts is the **ASIMOK** system, developed in a joint project between AGH and the largest polish insurance company – PZU. It is an active-safety system for vehicle drivers that learns personalized probabilistic driving profiles, detects anomalies and issues warning to the driver. It also implements crowd-sourcing and sharing of driving safety-related data, provides maneuver statistics and driving scores, and implements prototype accident detection algorithms. Most importantly, ASIMOK relies on sensory data collected from mobile phones. It can therefore be used as part of a standard mobile application, without any modification to the vehicle. ASIMOK project entitled "The active-safety system for the vehicle based on an individual model of the driver" was funded by the NCN-NCBR funding scheme TANGO and a contribution from PZU. It was executed between 2017-2020. Recently, ASIMOK was integrated with a mobile application and completed tests led by PZU on a group of 100 drivers. Currently it is being prepared for a large-scale deployment as part of the main PZU mobile application.

AI safety on the roads. The Intelligent system of prediction of permissible road speeds - RID-INPREDO project executed between 2016-2019 targeted developing a rule-based system for determining speed limits at selected road sections under the General Directorate for National Roads and Motorways. The expert system inferences are based on rules and data gathered in a static map. These rules can be defined by experts, extracted using machine learning methods or derived from the applicable law. Main outcomes of this project include development of a unified data model describing roads and their surroundings, identification of key factors influencing speed limits and the analysis of the viability of obtaining relevant data through an automated process of their collection. The goal of the **INZNAK** project (2017-2020) was to develop a decision module for an intelligent road sign operating in a distributed network of autonomous signs, thus enabling adaptive traffic control for vehicles communicating using V2X (vehicle-to-everything) technology. This solution is designed to provide a high level of autonomy for road signs in analysing the traffic situation (e.g. traffic parameters can be obtained via image processing) and deciding what message

should be displayed on the sign or passed directly to the driver. This system has been implemented at Doosan Babcock Corporation for ca. 30,000 users. Recently, new statistical metrics have been proposed to analyse the interpretability of DNN architectures for unlabelled data in vehicle interior.

[1] J. Jaworek-Korjakowska, A. Kostuch, P. Skruch: SafeSO: Interpretable and Explainable Deep Learning Approach for Seat Occupancy Classification in Vehicle Interior, CVPR, Safe Artificial Intelligence for Automated Driving Workshop, 2021

[2] W. Chmiel, I. Skalna, and S. Jędrusik, "Intelligent route planning system based on interval computing," Multimedia Tools and Applications, Oct 2018 (IF=2.101)

[3] A. Kłusek, M. Kurdziel, M. Paciorek, P. Wawryka and W. Turek, "Driver Profiling by Using LSTM Networks with Kalman Filtering," 2018 IEEE Intelligent Vehicles Symposium (IV), 2018

[4] W. Chmiel et al., Workflow Management System with Smart Procedures, Multimedia Tools and Applications, 2021 (IF=2.101)

Patent: A. Dziech, W. Chmiel aet al. System and the method to manage the rules of control of the traffic lights on the crossing, PL414870A1, BUP 11/2017, 11 2017

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).

[ERC Consolidator] ***Pragmatics of Multiwinner Voting: Algorithms and Preference Data Analysis*** (PRAGMA), PI: Prof Piotr Faliszewski, PhD, DSc. Years: 2021-2026, Budget: 1,386,290 EU.

In 2021 a faculty member at the AGH Institute of Computer Science received a prestigious ERC Consolidator award for a project devoted to computational social choice, an interdisciplinary research area at an intersection of AI and economy. The goal of this project is to develop methods that allow for practical applications of results from committee selection theory (in applications as diverse as selection of committees in various institutions, participatory budgeting, search engines, etc.). This goal includes designing new, efficient algorithms for computing outcomes in multi-winner voting systems (which often require solving NP-hard problems), finding algorithmic and theoretic insights that explain preference structures in multi-winner votes, and designing algorithms for analysing elections.

This is one of just three ERC Consolidator awards granted thus far to Polish Computer Science, and the first one in an AI subfield. The Principal Investigator, Piotr Faliszewski, consistently publish his research on computational social choice in top AI conferences, such as International Joint Conference on Artificial Intelligence or AAAI Conference on Artificial Intelligence (both ranked CORE A*).

[POIR NCBiR] ***An intelligent system for effective analysis of diagnostic and repair works of industrial devices with the use of mobile units and advanced image analysis*** (INRED), PI: Prof A. Dziech, PhD, DSc. Co-I: W. Chmiel PhD, DSc. POIR.01.01.01-00-0170/17, Cooperation with Doosan Babcock Energy Poland, Years: 2018 – 2023, Budget PLN 27,810,516 (approx. 6 621 551 EU).

The aim of this project is to develop a system integrating proprietary and innovative solutions, in order to apply augmented reality to visualization of renovation objects in 3D space and to support the employee during the implementation of complex repair and renovation procedures. The INRED system consists of: Knowledge Base Processes Platform, Object and Threat Recognition Module, Individual Diagnostic System, Knowledge Base Repository, and Semantic Search Engine.

[POIR NCBiR] ***Intelligent road signs for adaptive vehicle traffic control, communicating in V2X technology*** (INZNAK), PI: Prof A. Czyżewski PhD, DSc (lider), PI AGH: Prof A. Dziech, PhD, DSc, Co-I: W. Chmiel, PhD, DSc, POIR.04.01.04-00-0089/16. Coop. with Siled, Microsystem. Years: 2017 –2020, Budget PLN 6,902,082 (approx. 1 643 452 EU).

Results described in Section II.1.

[POIR NCBiR] ***X-rAI: Diagnostic viewer for computer-assisted radiology using Artificial Intelligence,*** PI: Prof Z. Tabor, A. Krzyżak, PhD, DSc, Co-I: J. Jaworek-Korjakowska PhD, DSc, POIR.01.01.01-00-1666/20. Coop. with Onwelo SA. Years: 2021-2023, Budget PLN 25,269,028 (approx. 6 016 425 EU).

The goal of this project is to develop a diagnostic viewer based on deep learning architectures to assist radiologist during the diagnostic process. During the execution of this research project new 3D multi-view CNN architectures will be proposed and evaluated.

[POIR NCBiR] ***EuroHPC PL: National Supercomputing Infrastructure for EuroHPC-EuroHPC PL,*** Coord. ACK Cyfronet AGH, Mariusz Sterzel, PhD, Years: 2021-2023, Budget PLN 160 102 219,69 (approx. 40 mln EU, 26 mln EU for AGH) .

A specialized infrastructure project for large-scale computing, enabling the undertaking of research challenges in key R&D areas important for Polish society, scientific community and economy. The supercomputers planned for installation will be based on next-generation networks, which will enable massive acceleration and scale-up of current neural networks and other AI models.

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 main research equipment required for development of AI solutions is provided AGH's Academic Computer Centre Cyfronet. It has at its disposal two large supercomputers – Prometheus and Zeus – each one with different hardware configuration characteristics, and therefore different uses. Prometheus has a theoretical computing power of 2.65 Pflops (PetaFlops), provided by 2,239 servers connected by an ultra-fast InfiniBand FDR network (with a capacity of 56 Gbit/s). Prometheus has 53,748 computing cores (Intel Haswell and Intel Skylake generations) and 283.5 TB of RAM. It is equipped with two file systems with a total capacity of 10 PB and a very high access speed of 180 GB/s. Thanks to the innovative technology of direct liquid cooling of processors and memory modules, it is also one of the most energy-efficient computing systems of this class in the world. Importantly, Prometheus is equipped with 144 NVIDIA Tesla K40 XL GP-GPUs and 32 NVIDIA Tesla V100 cards. The V100 GP-GPU server set with fast interconnect is an excellent platform for developing and training artificial intelligence systems. It is also worth adding that this GP-GPU cluster provides over 4 PFlops of computing power for tensor operations and 256 TFlops for standard double precision calculations, which makes it **one of the fastest dedicated solutions for artificial intelligence available for science in Poland.** Zeus is a cluster based on slightly older generation processors: Intel Xeon Westmere and AMD Opteron Bulldozer, as well as NVIDIA Tesla M2070 and M2090 GPGPU cards. In total, Zeus has 25,468 computing cores, 60 TB of RAM and 208 GP-GPU cards connected via the Infiniband QDR network with a speed of 40 Gb/s.

Two more computing systems are planned for launch in 2021: Ares computing cluster with a theoretical computing power of over 4 PFlops, equipped with 38,112 Intel Xeon Cascade Lake computing cores, 204 TB of RAM and 72 NVIDIA Tesla V100 SXM2 32 GB GP-GPU cards. Ares will have Infiniband EDR (with a speed of 100 Gb/s) as an interconnect. Along with the computing cluster, a disk system with a capacity of almost 12 PB will be launched. **Another system planned for installation this year is the fastest computing cluster in Poland dedicated to AI computing, which will be equipped with almost 400 NVIDIA Tesla A100 GP-GPU cards with a theoretical computing power of 240 PFlops for AI operations.** This system will also have over 1.5 PB of ultra-fast NVMe flash memory and a next-generation interconnect network: Infiniband HDR with a speed of 200 Gb/s. These computing systems will be integrated into one coherent computing environment and attached to the existing Cyfronet data storage system, based on multi-level disk and tape resources, with a capacity of over 50 PB. All systems are installed in specially designed server rooms with high power density, ensuring continuity of power and cooling. This is realised via multi-level security, such as UPS and power generators. The server rooms are supervised 24 hours a day and covered by an access control and monitoring system.

In addition to the hardware infrastructure, Cyfronet also maintains a ready-to-use software library, consisting of numerical and communication libraries, compilers, tools facilitating the development of custom applications, and several hundred ready-to-use scientific applications optimised to work on supercomputers available to users.

Resource allocations are based on the PLGrid Infrastructure grant system. Cyfronet also provides specialised user support as part of the Helpdesk system, as well as training dedicated to the use of available hardware and software technologies. This specialised training is based on internal resources and competences, as well as support from market leaders in HPC and AI computing, such as Intel, NVIDIA or ARM.

Apart from the IT infrastructure dedicated for AI research projects, the allocated space includes autonomous driving lab with, among others, Ford Explorer car with telemetry platform, dSPACE SCALEXIO Simulator for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) simulations, Expansion Boxes dSpace PX20 and MicroAutobox II dedicated for vehicle automation systems. The Virtual Reality Room is equipped with HoloLensII, Oculus Quest 2, DJI Goggle FPV, as well as drones. We are planning to open a reinforcement learning laboratory for robotic research projects.

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

AGH-UST is one of the best and most renowned Polish university and an important hub for developing and transferring innovative technologies and knowledge to the industry. The AGH-UST educates more than 25,000 students at all types of programmes – full-time, part-time, doctoral and postgraduate – offering a wide scope of education adapted to current trends on the labour market. The educational offer for Bachelor's and Master's degree encompasses over 60 branches of studies, including over 200 specializations run at 16 faculties. Currently AGH employs more than 2,000 research workers, including over 200 full professors and 500 university professors.

AGH has large infrastructure, modern teaching and research facilities, good student accommodation and very well-equipped sports facilities. A unique feature of our campus – in comparison to other Polish universities – is the fact that research and teaching facilities, university administration, student organisations, sport and recreational facilities are all located in one district of the city. Buildings owned by AGH-UST, whose total floor space equals 40 ha, are located in the heart of Krakow. Thanks to significant investments, our community has gained a possibility to acquire knowledge in modern laboratories. Constantly **modernised research and teaching facilities create space for scientific research projects at a very high level.** AGH has at its disposal over 150 lecture rooms, 200 rooms designed for practical classes and discussions, 680 laboratory-type rooms, 40 conference rooms and theatres. The structure of AGH University of Science and Technology encompasses following administrative units: **16 faculties, research centre, doctoral schools**, teaching centres, auxiliary organisational units, and central administration. Research is conducted in **16 scientific disciplines,** including Computer and Information Sciences, Information and Communication Technology, Automation, Electronic and Electrical Engineering.

The prospective research group will be primarily affiliated with the Institute of Computer Science (WIET) and the Department of Automatic Control and Robotics (WEAIiIB). Office space allocated for **the AI Centre of Excellence will be located in two modern buildings** with fully equipped office rooms, computer labs with advanced computing equipment and laboratories dedicated to specific research projects, including autonomous driving, virtual reality, and reinforcement learning. AGH will provide for the AI Centre administrative office rooms, single/double staff rooms, meeting rooms, rooms for PhD students, etc. AGH-UST also has **modern, large, well equipped lecture rooms**.

AI Centre will be supported by the **Academic Computer Centre Cyfronet AGH** with computing power, disk space, tape storage resources and access to specialized scientific software for high-performance computers. Cyfronet also provides advice, expertise, training and development of staff skills in computer science, computer networks, high performance computers and computer services, which is crucial to efficient implementation of research and development projects that require high computing power.

AGH also offers support in matters related to protection of intellectual property and other outcomes of R&D projects, as well as commercialisation of project outcomes. This is a responsibility of **The Technology Transfer Centre.** Moreover, The Technology Transfer Centre provides services related to technology transfer, transfer of intellectual property and coordination of contacts.

Additional offer and benefits:

- AGH – UST will provide additional funding from its own budget for the AI Centre and provide stipends for additional PhD students,
- AGH – UST will assist in residence formalities for the leader and his/her family, school arrangement, employment formalities, health insurance, as well as public transport card, polish language course, Multisport card, entry cards for cultural events and guided tours.

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

International collaboration is one of the most important elements of the educational and academic development of AGH. It is regarded as a cornerstone for raising international prestige, improve research quality and build leadership. AGH-UST provides support in obtaining international grants and scholarships, is active in exchange of academic staff and students, and participate in international research and educational programmes. AGH-UST has signed over **250 direct collaboration agreements** with foreign partners in Europe, North and South America, and Asia. These agreements strengthen cooperation in education and academic research. Each year, in collaboration with foreign partners, AGH-UST conducts over **100 research projects**, including those covered by the **EU Framework Programmes, KIC InnoEnergy, KIC RawMaterials, EEA Grants and Norway Grants, European Space Agency, European Social Fund POWER, COST, EUREKA,** and **CERN.** Alongside these projects, AGH-UST also carries out projects outlined by the Ministry of Science and Higher Education within the framework of intergovernmental agreements. It participates in many educational projects supported by programmes such as **Erasmus LLP, Erasmus+, Motorola Solutions Foundation grants**, and the **European Social Fund**. Currently, AGH has over 200 agreements in the Erasmus LLP programme, which include the exchange of students and lecturers. Before the Covid pandemic, the offer for **academic exchange was granted – each year – to over 180 Students**. In 2020, 35 foreign academic staff were carrying out research and teaching at AGH-UST. Since 2020, the AGH-UST decision organs including the University Board have international members.

Caring about the competitiveness of its educational offer on the international education market, AGH-UST develops teaching in English. Specifically, **in recent years AGH-UST increased the number of courses and fields of study at which education is provided in English. Currently, education in English is offered at 16 fields of study (1st and 2nd cycle of studies)**. **Moreover, AGH maintains a University Catalogue of Courses in English, which offers over 180 courses in foreign languages.** Courses from this catalogue are available to all AGH-UST students, and include AI courses at each level. They are also intended as an educational offer for all students coming to AGH-UST within the framework of various international exchanges programmes. **AGH-UST hosts over 500 foreigner students. Furthermore, 30 international PhD Students attend the Doctoral School.**

AGH-UST is a member of many **international organisations, including EUA (European University Association)**, **IAU (International Association of Universities)**, **T.I.M.E. (Top Industrial Managers for Europe), CEEPUS (Central European Exchange Program for University Studies), IROs Forum (International Relations Offices Forum), SPIRE (Sustainable Process Industry through Resource and Energy Efficiency), UN Global Compact (United Nations Global Compact)**. As a technical university, AGH-UST is actively pursuing collaboration with businesses and industry. It has signed partnership agreements with **approximately 300 industry partners**, including large international corporations. Furthermore, AGH-UST established Intelli-NET Artificial Intelligence Platform, intended to gather knowledge and stimulate development of research and teaching related to computational intelligence.

International cooperation and exchange are essential in AI research. We cooperate closely with many institutions, including Stanford University, Metropolitan Manchester University, University of Sheffield, University of Texas at Austin, Dalhousie University, University of Pennsylvania, Curtin University, University of the Basque Country, CERN, and other.

The Academic Computer Centre Cyfronet AGH provides European High Performance Computing Joint Undertaking seminars and courses, including "**Cyfronet & NVIDIA OpenACC Bootcamp workshops**" organised together with NVIDIA. High-quality of training and other activities that supports scientific community and broader economy are confirmed by granting Cyfronet the leader role in the **Polish HPC Competence Center under the EuroCC project**. Cyfronet provides bilingual documentation of computing services and access tools, such as the PLGrid Portal or the helpdesk system. Advanced user support is provided also in English.

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

In 2019 AGH-UST has been chosen to the **"Initiative for Excellence – Research University 2020-2026"** programme, which – apart from prestige – ensures additional 10% funding between 2020 and 2026. Actions proposed within the framework of the **Strategic Program of Excellence Initiative** encompass funding in elected priority research areas, including **"Intelligent information, telecommunication, computer, and control and operation technologies"**. Furthermore, Initiative for Excellence opens opportunities for international collaboration, staff mobility, and hosting of foreign scientists.

Former and current faculty members of AGH's Cyfronet and Institute of Computer Science embarked on a project to open a **new international scientific institute devoted to computational medicine**. This project received a highly prestigious **EU Teaming for Excellence award**, together with funding from Foundation for Polish Science and from Polish Ministry of Education and Science. This led to funding of a new research institute in Cracow: **Sano (https://sano.science).** Sano is an independent research institute but is closely collaborating with AGH (a formal collaboration agreement was signed in 2020), LifeScience Krakow Cluster, University of Sheffield, Insigneo Institute, Forschungszentrum Jülich and Fraunhofer Institute for Systems and Innovation Research. Sano scientific programme includes, among others, research in areas such as data science, artificial intelligence and machine learning. This provides a fertile ground for successful cooperation on AI projects.

AGH Institute of Computer Science participates in CERN experiments: TOTEM (since 2013), CMS (since 2018) and ALICE (since 2020). CERN focuses expertise not only in High-Energy Physics, but also in many other fields of science and technology. Among these is a cutting-edge expertise in large data analysis and interpretation. Institute of Computer Science contributes to this scientific prowess with research on parallel and distributed computing, big data and machine learning. This experience lies squarely at the centre of research topics in modern AI. **Department of Automatic Control and Robotics (WEAIiIB) collaborates with the National Synchrotron Radiation Centre SOLARIS** in areas related to deep learning-based anomaly detection in large datasets and in development of a diagnostic research infrastructure for the analysis of environment's influence on beam stability in particle accelerators.

Our faculty members published results of their research at AGH in **top ranked (CORE A*, CORE A) AI conferences** – including NeurIPS, CVPR, CVPR workshops, IJCAI, AAAI, AAMAS, EMNLP, ECCV – and **top AI journals**, e.g. Journal of Artificial Intelligence Research, Artificial Intelligence. Furthermore, our research has been recognized by many best paper awards, including Honorable Mention Award CVPR'19 ISIC workshop. Our faculty members serve **as program committee and editorial board members in top AI journals and conferences** (Journal of Artificial Intelligence Research, IJCAI, AAAI, CVPR'21 ISIC workshop Program Committee). Since 2016 **over 200 grants and awards have been granted to AGH-UST by international funding institutions**, including the **prestigious European Research Council grants**, and Polish institutions such as the Foundation for Polish Science, The National Science Centre and The National Centre for Research and Development.

Currently, AGH is the only polish research institution that can award habilitation degree in two Computer Science-related disciplines recognised by Polish law, namely Computer and Information Science as well as Technical Computer Science and Telecommunications.

The Academic Computer Centre Cyfronet AGH is actively involved in international infrastructure projects such as **WLCG (The Worldwide LHC Computing Grid), EGI (Advanced Computing Services for Research), PRACE (Partnership for Advanced Computing in Europe)** and **EuroHPC (The European High Performance Computing Joint Undertaking)**. Thanks to the EuroCC project, Cyfronet coordinates the national activities with activities carried out by the other 30 countries that are EuroCC partners. One of the scopes of activity is cooperation in knowledge transfer and training, as well as development of good practices in providing of computing infrastructure and expert knowledge in computational methods – including artificial Intelligence – for the science and economy.