



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>	<b>LODZ UNIVERSITY OF TECHNOLOGY</b>
<b>Name (short)</b>	<b>TUL</b>
<b>Name of the main organisational unit</b> (where applicable)	-
<b>Address of the registered office</b>	
Street	ŻEROMSKIEGO
Building No.	116
Office No.	-
Postal code	90-924
City/district	LODZ
Post office	LODZ
Municipality	LODZ

County	<i>LODZ</i>
Province	<i>LODZKIE</i>
<b>Correspondence address (if different than the address of the registered office)</b>	
Street	
Building No.	
Office No.	
Postal code	
City/district	
Post office	
Municipality	
County	
Province	
EPUAP [Electronic Platform for Public Administration Services] mailbox	<i>/PolitLodz/SkrytkaESP</i>
<b>Legal form</b>	<b><i>PUBLIC UNIVERSITIES</i></b>
<b>The person appointed for contact with NCBR and with the potential Leader/Project Manager</b>	
First name	<i>ANDRZEJ</i>
Last name	<i>ROMANOWSKI</i>
Position	<i>VICE-RECTOR FOR EDUCATION</i>
Phone number	<i>+48 42 631 27 50</i>
E-mail address	<i>ANDRZEJ.ROMANOWSKI@P.LODZ.PL</i>
<b>The person authorised to represent the applicant</b>	
First name	<i>KRZYSZTOF</i>
Last name	<i>JÓŹWIK</i>
Function/Position	<i>RECTOR</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).

Lodz University of Technology (TUL) has extensive experience in R&D and scientific work related to AI. Over the last 5 years, a number of large (several tens of millions PLN in total) and smaller AI projects have been successfully implemented. The selected achievements are presented in key areas (TUL's partners in parentheses).

TUL researchers together with partners (NUS Singapore, Chalmers Sweden, LMU Germany) have developed a number of innovative solutions dedicated to Industry 4.0. These implementations include intelligent systems for monitoring and control of industrial processes using big data sets of tomographic measurements supplemented with AR technology and based on Bayesian inference, MC and ML models developed using, among others, crowdsourcing algorithms (Helmholtz FZD, et al.). In medical applications, algorithms for analysis of sensed vital signs data have been implemented in non-invasive wearable devices that remotely monitor lung and heart function, or basic parameters of senior citizen (Netrix). One of the major successes were developments of glycaemic data analysis of CGM systems records to determine the degree of decompensation while maintaining the ability to detect health and life-threatening conditions as well as research on intelligent algorithms to assess ovarian and pancreatic cancer risk based on the expression of microRNAs circulating in the blood and computational intelligence of matching registered drugs to metabolic pathways for selected cancer types (UMED, Dana-Farber Cancer Institute, USA). TUL has also published a number of papers on medical image processing relevant to lung, vascular and cancer diagnostics. The developed algorithms based on ML, ANN and DL have been successfully implemented in diagnostic systems (Skopia Estetic, UCA France). In 2020, a globally unique software package with dedicated models for intelligent search and processing of digital evidence data was implemented for the Polish Police. Thanks to AI methods, operational efficiency has been increased with the minimisation of expert participation and multiple reduction of the volume of irrelevant data, resulting in reduced investigation time, improved cyber-security and more effective prosecution of economic, paedophile, digital crime, etc. (CLKP, KGP). Implemented in 2021, the unique commercial SaaS-based consumer data processing AI platforms for the digital marketing and advertising industry called pDMP, enable intelligent user profiling with the highest ethical standards (ASM, NVT, Inovatica). An emphasis put on the ethical side of technology development and its impact on both the society and the individuals are the important aspects that distinguish TUL's policy in the field of AI; TUL puts emphasis on the ethical side of technology development. The human factor in AI is particularly explored in research related to the use of AI in user-centric systems designed at TUL (Blink, Hapticollar, Swingmate, Subtletee, Spiderhand, HomeU et al.) In this thread, there is research work at the intersection of AI and HCI conducted with Harvard University on making AI systems more efficient. The results of these 2021 studies (cognitive forcing functions in AI-based decision support systems) will become a guidepost for the design of intelligent and hybrid CSCW-class systems in the coming years. It is worth emphasising that the research work at TUL is not solely geared towards commercial development through the implementation of ad hoc innovations but is a well-thought-out evolution of the use of AI respecting the directions and principles of sustainable progress of civilisation and in the long term the welfare of the end users. Selected bibliography by DOI identifiers: [1] 10.1007/s00521-020-04976-7, [2] 10.2478/jaiscr-2021-0006, [3] 10.1016/j.patrec.2020.05.029, [4] 10.1093/bioinformatics/btz919, [5] 10.1109/ACCESS.2019.2923687, [6] 10.1016/j.engappai.2019.02.006, [7] 10.1002/int.22059, [8] 10.1016/j.artmed.2018.04.004, [9] 10.1093/bioinformatics/bty670, [10] 10.1109/TII.2018.2855200, [11] 10.1089/dia.2018.0247, [12] 10.1145/2897370. Selection of other important AI-related publications by TUL in Scival: [www.scival.com/overview/authors?uri=Institution/327025](http://www.scival.com/overview/authors?uri=Institution/327025)

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).

A) **Project title:** *VLSI analogue integrated circuit for intelligent analysis of short and medium wave radar data*

**Project coordinator:** prof. dr hab. inż. Krzysztof Ślot (PŁ)

**Source of funding:** CHIST-ERA 2018 competition, funding institution: NCN - international cooperation, implementation time: 2020-2023

**Project budget:** EUR 622 223.20

**Consortium members:** Politechnika Łódzka (Lodz University of Technology) - consortium leader; VTT: Technical Research Centre of Finland Ltd. LNE: Laboratoire national de métrologie et d'essais), France

B) **Project title:** *Development of software for digital data acquisition*

**Project coordinator:** : dr hab. inż. Andrzej Romanowski, Prof. PŁ (TUL)

**Source of funding:** funded by the Homeland Security Fund, funding institution: Chief of Police, implementation time: 2018-2020

**Project budget:** 2 398 500 PLN

**Innovative partnership** - Lodz University of Technology, the Police Central Forensic Laboratory and the Communications and Information Technology Bureau of the National Police Headquarters.

C) **Project title:** *Intelligent tomographic sensors for advanced industrial process control*

**Project coordinator:** dr hab. Laurent Babout, Prof. PŁ (TUL)

**Source of funding:** MSCA ITN ETN Horizon H2020 competition; funding institution: European Research Executive Agency; implementation time: 2017-2021

**Project budget:** EUR 3 819 642.12

**Consortium members:** Helmholtz HZDR Dresden DE-coordinator, Politechnika Łódzka PL, Chalmers SE, TU Delft NL, INP Toulouse FR, Karlsruher KIT DE, LLTYL FI, TU Liberec CZ, Bath U. UK, ISY FI

D) **Project title:** *Multispectral Intelligent Vision System with Embedded Low-Power Neural Computing - 'MISEL'*

**Project coordinator:** : prof. dr hab. inż. Krzysztof Ślot (PŁ)

**Source of funding:** H2020-FETPROACT-2020-01 (FET to Future Emerging Technologies), implementation time: 2021-2023

**Project budget:** EUR 4 969 451.25

**Consortium members:** Teknologian Tutkimuskeskus VTT OY (VTT), Finland– koordynator, AMO GmbH, Germany, BUW Wuppertal, Germany, Kovilta Oy, Finland, USC, Spain, Fraunhofer e.V. Germany, Politechnika Łódzka, Poland, LNE, France, Lunds ULUND, Sweden.

E) **Project title:** *Application of artificial intelligence in optimisation solutions for truck transport*

**Project coordinator:** : dr hab. inż. Piotr Lipiński, Prof. PŁ (TUL)

**Source of funding:** competition POIR 1.1.1- Fast Track, funding institution: NCBR, implementation time: 2020-2021

**Project budget:** PLN 7,346,925. 13

**Consortium members:** INELO POLSKA Sp. z o. o., Politechnika Łódzka

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).

TUL has technical potential and modern technical resources, equipment, and facilities. The University has a modern Information Technology Center (ITC) with the state-of-the-art IT equipment worth approx. 40 million PLN, located in twenty specialist laboratories with 400 computer stations, along with a wealth of accessories, software, and cutting-edge network infrastructure. Each of the laboratories has additional specialist equipment dedicated to different applications, including a number of programmable devices, such as Arduino boards, Raspberry Pi microcomputers, mobile devices: smartphones and tablets (Android and iOS systems), multitouch tables, programmable robots, wheeled and flying platforms, sets with bioelectric sensors and software, sets of professional drones, etc. The equipment available enables programming in different languages, also using ML/AI libraries and frameworks. TUL ITC provides the possibility of working on-site or remotely in most of the laboratories, with access to computing clusters located in the server room in the building. Apart from ITC, also some of the faculties, mostly the Faculty of Electrical, Electronic, Computer and Control Engineering and the Faculty of Technical Physics, Information Technology and Applied Mathematics, have a few dozen of specialist IT laboratories, with extensive specialist computing infrastructure and research equipment. These include computing infrastructure and GPU servers, such as AMD Epyc 7702P computing servers, with 1024 GB RAM of 8 Nvidia Quadro RTX 6000 graphic cards each; servers with AMD Ryzen 9 3950X processors and GPU GeForce RTX 2080 cards; GPU 8x GeForce RTX 2080i computing blades used for work connected with different types of deep neural networks and so-called neuro-symbolic hybrid systems combining the advantages of symbolic processing and self-learning systems, which are today among the most important research streams aimed at the so-called Explainable AI or systems with the highest trust rating. The extensive infrastructure for the acquisition of data which is then modeled/analyzed using AI/ML, Leica 3D laser scanners, an Artec structured light scanner, a motion capture system and a 3D cave, EMG sets, EEG, controllers, and manipulators. Both faculties also have a few VR laboratories (TUL is a leading institution in Poland with regard to VR and computer games) and AR/MR dedicated for the development of general and therapeutic applications, computer forensics, and cybersecurity.

TUL is an operator of a unique 5G separated campus research mobile network. The possibility to communicate effectively with a very large number of devices, along with the use of AI methods and negligible delays, form the basis for the development of the Internet of Things services and implementation of the intelligent city concept. The created academic pilot 5G network covers the area of two campuses (campus 'A' and campus 'B') of Lodz University of Technology. An internal 5G network makes it possible for companies (startups, SMEs) to test innovative services and prototypes of their AI-based applications/services. Moreover, TUL is the leading unit and operator of the LODMAN municipal computer network and a participant in the national PIONIER optical network.

It is worth pointing out the access of talented young people to the TUL resources. Today, activities connected with AI are conducted as part of such programs as Computer Science, Applied Computer Science in Polish as well as Computer Science, Information Technology, CS&IT, Human-Computer Interaction, and Modeling and Data Science in English. A second cycle study program in Artificial Intelligence will be launched soon, and at the moment the aforementioned study programs offer specializations such as AIML (Artificial Intelligence and Machine Learning). Almost 2,000 students study at these first and second cycle programs. Moreover, the University has a few dozen of PhD students of Technical Computer Science and Telecommunication.

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

Politechnika Łódzka (PŁ) - Lodz University of Technology (TUL) is shaping policy in the area of AI, which is in line with the Sustainable Development Goals (SDGs). The priority objectives are: (1) Scientific excellence - in the indicated priority research areas of Lodz University of Technology, two are strongly related to AI, i.e.: innovative applications of artificial intelligence and intelligent and secure infrastructure; the research areas are focused on improving the quality of life, clean energy sources and technologies, and digital transformation accessible to all. (2) High level of education - in which innovative educational methods based on the involvement of students and doctoral students in research work have been implemented.

The Rector's Office has prepared a coherent ecosystem of incentives for research development and creation of a Centre of Excellence in AI. That includes a series of infrastructural measures, staff development programmes, and an enhancement of scientific and R&D quality in cooperation with the leading scientific centres and industrial partners from Poland and abroad. The appropriate space has been allocated in two modern buildings at Lodz University of Technology. In the TUL campus, in the building of the Centre for Information Technology at Wólczańska Street there is a number of specialized computer laboratories and a modern server room with already running computational clusters, which will be used for the work within the ArtIQ Excellence Centre. In addition, Lodz University of Technology is currently carrying out an investment in the form of a newly constructed, ultra-modern passive building, located in Lodz, Wólczańska Street, which is scheduled to be put into operation in the fourth quarter of 2021. This building has been specially designed to meet the criteria of energy indifference, including AI CoE office space, research and control infrastructure related to testing passive technologies, intelligent buildings and human-building interaction research, as well as a modern showroom to be used also by ArtIQ. The complementary programmes are being implemented at Lodz University of Technology to support the acquisition of highly qualified staff, including staff members from abroad. Lodz University of Technology is among 21 Polish universities implementing the IDUB programme. One of the IDUB activities at Lodz University of Technology being implemented in 2021 is the YES Programme (Young Excellent Scientists). This programme aims to strengthen the capacity and create new teams led by outstanding young researchers from Poland or abroad, who will receive competitive remuneration and comprehensive support from Lodz University of Technology. The first edition of YES will be dedicated to recruiting AI specialists. TUL is a partner of the Artificial Intelligence Economic Development Corporation in implementing AI projects commercialised in the USA. In one of the projects on predicting the success of companies in Silicon Valley, among others, we cooperate with P. Romer, 2018 Nobel Prize winner, K. Skrinak, the global director of the ML team at AWS and the former director at NASA, A. Nawrocki. Working on such projects and having the opportunity to collaborate with scientists of such calibre creates an invaluable potential for the personal development of current and future AI researchers at TUL. A close cooperation with the Police in the implementation of the number of projects for Central Forensic Laboratory of the Police (CFLP) and Forensic Laboratory of the Regional Policy in Lodz have laid the foundations for a centre for digital forensic research that is unique in the Central Europe. The recent successes achieved by Lodz University of Technology, also thanks to its competence in AI, have additionally led to the cooperation with the Marshal of the Lodz Voivodship, who is collaborating with TUL in the creation of the first Centre for Computer Forensics and Cybercrime, subsidising, among other things, a laboratory for digital modelling of crime scenes. It confirms the support of the local authorities for the development of the AI field both at TUL and in Lodz. The University Council, under the leadership of M. Sopek, PhD, the founder of MakoLab, has issued a recommendation to conduct an assessment of the potential in the area of AI in the scientific disciplines, in which the applied computational paradigms based on AI allow for obtaining new quality results (e.g. chemistry and quantum physics, molecular modelling, materials engineering, control engineering, etc.), in order to develop a strategy for strengthening those scientific specialities in which the results have been achieved at a high international level.

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

Internationalisation is one of the foundations of the TUL Development Strategy in the field of research, education, as well as other activities carried out in cooperation with the social and economic environment. In cooperation with foreign centres, TUL participates in research and educational programmes and projects (Horizon 2020, Erasmus+, Campus Europae or International Atomic Energy Agency Project), jointly prepares publications and diploma theses (within dual diploma programmes e.g. with French ENSAM, ECAM), gives lectures at strategic partner universities and participates in exchange of employees and students, through scientific conferences and organisation of such events in TUL. The strategic partners of TUL include universities, educational and scientific institutions and organisations (e.g. research institutes) and companies. The strategic foreign partners of TUL include e.g. RWTH Aachen (Germany), University of Twente (the Netherlands), DTU (Denmark), Universitat Politècnica de Catalunya (Spain), University of Aveiro (Portugal), University of Pavia and University of Padova (Italy) and ECAM Cluny and ECAM Lyon, Ecole Centrale de Lyon or INSA Lyon, University of Strathclyde in Scotland. In the area of research and scientific activity, TUL employees implement international projects and cooperate with scientists from all over the world including prof. Dalia Streimikiene, prof. Albrecht Schmidt, prof. Krzysztof Gajos, prof. Shendgong Zhao, prof. Morten Fjeld, prof. Dalia Streimikiene, Prof. Roman Rospial, Prof. Igor Djurovic, Prof. Yuriy Bilan, Prof. Natalia Kryvinska, Prof. Remy Dupas, Prof. Fatos Xhafa, Prof. Oren Shriki, prof. Karol Myszkowski, prof. J. Widom and others. TUL has repeatedly organised international seminars i.a. in the subject of EEG signal analysis, the use of Artificial Intelligence in the synthesis and analysis of graphic images, environmental process modelling, sustainability and energy management. The university is strongly focused on the mobility of staff and students. In all CS IT programs conducted in English, students have compulsory programme mobility. Students also go on research placements (e.g. LMU Monachium, NUS National University of Singapore, Harvard University, USA). As part of the NAWA-PROM programme, in the area of AI, the exchange of doctoral students is carried out with, for instance Chalmers University of Technology, Sweden. An important initiative to develop international cooperation, as well as to encourage people to come to TUL, are summer schools (e.g. Research Methods in HCI Summer School, Connect'em All IoT, Dt Destine Intensive Programme) implemented in an international environment that attracts a large number of students from different countries. These schools have been co-led by an international staff - professors from Harvard University (K. Gajos), and other universities in the USA (A.Kun New Hampshire, O.Shear Wellesley College, E.Brady Indiana-Purdue Uni,), Europe: (G.Fitzpatrick Vienna Uni. N.Marquardt UCL) incl. ERC grant holders (Albrecht Schmidt - LMU Munich).

TUL also organises so-called thematic Training Weeks for representatives of teaching and research staff from various countries. Such Peer Learning Activities took place also in the area of AI and Data Science, with an exceptional example of workshops and lectures conducted by the Dean of Stanford's Faculty of Engineering, Prof. Jennifer Widom.

TUL was one of the precursors of education in foreign languages in Poland. It was initiated in the International Faculty of Engineering (IFE) set up 30 years ago. Currently, in the field of CS-IT (incl. AI). Three first cycle programmes and two second cycle programmes are run in this unit entirely in English. In these areas, particular attention is devoted towards innovative teaching methods developed including design thinking, problem based learning, research based learning, case teaching, flipped education that have been developed and carried out in cooperation with international staff.



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

Lodz University of Technology, together with Instytut Łączności PIB (National Institute of Telecommunications), Ericsson Sp. z o.o. and FundingBox Accelerator Sp. z o.o. are partners in the Digital Innovation Hub 5G project. DIH 5G activated a pilot fifth generation mobile network at TUL campus. The 5G infrastructure of which TUL is the operator, is used by entrepreneurs, scientists, and students (over 1,000 SIMcards). Trial services are related to capacity tests for solutions using networks, e-health and connectivity with drones. The purpose of 5G in the campus is to promote Industry 4.0 development as well as to test innovative services, also those based on AI; especially such services that have not been available before, due to substantial delays of the Internet and 4G networks, e.g. the presently tested systems for supporting the blind in their everyday activities and in spatial orientation, or connection and control of drones by TUL researchers. Moreover, the research 5G network is used by SMEs, which is of critical importance for constructing an innovative ecosystem, based on AI and 5G. At the moment Lodz University of Technology is the only Polish University (and one of few in the world) that has its own 5G network. The TUL campus is a great testing ground – it is like a small town with buildings of different ages, numerous parks and 20 thousand ‘inhabitants’ (students and staff). The base stations are located in the different parts of the campus, there is even a *zero site* base station, integrated with a street lamp. TUL has extensive experience in leading and participating in the work of different consortia and research centres, also the dispersed ones. An example of such an experience, as well as its organisation and research potential, is the collaboration with TREX. TUL is one of the partners of the European Centre for Excellence in the field of TREX exascale computation. TREX is a consortium of 12 partners from the Netherlands, France, Italy, Germany, Slovakia, and Austria. The researchers from Lodz University of Technology participating in it are engaged in developing programs for quantum simulation, which shall be used in the computers that are only now being developed, capable of reaching the performance of 1 exaflops. The exascale computer performance will allow for making simulations well beyond the abilities of present-day machines. It will be possible, for example, to conduct highly efficient team simulations such as screening a huge number of medicines in order to quickly find the most effective ones. Another element that is important for validating the highest quality of resources, in this case – human resources, is a ranking of the most cited researchers. In the list of World’s Top 2% Scientists, published in 2020, there is a large, almost 30-people group of TUL Professors. In a work ‘*Updated science-wide author databases of standardized citation indicators*’ published in *PLOS Biology* the authors created an algorithm which includes many factors characteristic for citation indicators’ studies. Based on the algorithm they made a classification of scientists in the various fields [1]. It is worth emphasizing that two TUL IT scientists engaged in research activity in the field of artificial intelligence were placed among the 2% of the best scientists in 2019. The first one is TUL’s Professor Anna Fabijańska, Eng. PhD, holding the position of the President of the Technical Informatics and Telecommunications Field Council at TUL. Prof. Fabijańska is mostly interested in image processing algorithms and artificial neural networks. The other scientist is TUL’s Professor Andrzej Romanowski, Eng. PhD, holding the position of the Vice-Rector for Education, who, in his everyday scientific work, studies the human-computer interaction and Industry 4.0; he models phenomena and processes with the use of big data, ML, crowdsourcing, as well as context algorithms. TUL is the establishing body and the coordinator of the ICT Central Poland Cluster consisting of 33 entities, including innovative companies and universities running AI projects (such as: University of Lodz, Ericsson, Transition Technologies, Fujitsu, Makolab, ABB, etc.), employing around 25 thousand people.

[1] Ioannidis JPA, Boyack KW, Baas J (2020) Updated science-wide author databases of standardized citation indicators. *PLoS Biol* 18(10): e3000918. <https://doi.org/10.1371/journal.pbio.3000918>