



POZNAN UNIVERSITY OF TECHNOLOGY

Extended information about Poznan University of Technology with respect to its capacity to be a Host Institution in ARTIQ – AI Centres of Excellence Program

(an excerpt from the Host Institution application)

7 June 2021

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.

The Host Institution (**Poznan University of Technology, PUT**) features a number of units that are actively pursuing R&D projects in the area of AI and machine learning (ML), primarily the Faculty of Computing and Telecommunications (**WIiT**), Institute of Computing Science (**II**), and Institute of Robotics and Machine Intelligence (**IRIM**). In the last 5 years, the II and IRIM have published over **100 papers** in top AI and ML conferences, e.g., **NeurIPS, ICML, ECML, COLT, PAKDD, GECCO, IJCNN, IROS, ICRA, ICARCV, IJCAI** and journals, e.g., Journal of Machine Learning Research, Machine Learning Journal, Information Sciences, Knowledge-based Systems, Data Mining and Knowledge Discovery, IEEE Transactions on Neural Networks and Learning Systems, IEEE Robotics and Automation Letters, IEEE Transactions on Evolutionary Computation. They obtained also 18 European and US patents, among others on reliable self-testing electronic circuits for autonomous vehicles and on depth estimation and object tracking in computer vision.

The contributions elaborated in publications and patents have been applied in numerous R&D projects conducted with business partners, including contextual perception of the environment and localization of buses (in collaboration with Solaris Bus & Coach), forecasting of energy demand (Kogeneracja Zachód), recognition and analysis of ingredients of food products (Syndigo), anomaly detection in medical imaging (Roche), vehicle routing and fleet optimization (eMapa), ML for efficient generation of digital maps (TomTom), customers behavior analysis for an e-book library (Legimi), spoken language understanding (Orange Labs), analyzing data from assembly lines (Volkswagen), and synthesizing avatars in computer games (Netictech).

PUT's research contributions to intelligent systems concern primarily machine learning and computer vision, in particular **online learning, learning from data streams, classifying complex data, multi-label classification, and perception methods in computer vision and robotics**, as evidenced with the following significant publications and patents:

P. Liskowski, K. Krawiec: *Segmenting retinal blood vessels with deep neural networks*. IEEE Trans. on Medical Imaging 35.11, 2016

M. Kempka, W. Kotłowski, M.K. Warmuth: *Adaptive scale-invariant online algorithms for learning linear models*. International Conference on Machine Learning, 2019

D. Brzeziński, J. Stefanowski, R. Susmaga, I. Szczęch: *On the dynamics of classification measures for imbalanced and streaming data*. IEEE Trans. on Neural Networks and Learning Systems 31.8, 2019

M. Wydmuch, K. Jasinska, M. Kuznetsov, R. Busa-Fekete, K. Dembczyński: *A no-regret generalization of hierarchical softmax to extreme multi-label classification*. Advances in Neural Information Processing Systems, 2018

L. Wellhausen, A. Dosovitskiy, R. Ranftl, K. Walas, C. Cadena, M. Hutter: *Where should I walk? Predicting terrain properties from images via self-supervised learning*. IEEE Robotics and Automation Letters, (4):2, 2019

M. Domański, et al.: *System and a method for depth-image-based rendering*. US Patent No. 9,582,859. 28 Feb. 2017

M. Domański, et al.: *System and a method for disoccluded region coding in a multiview video data stream*. US Patent No. 9,992,514. 5 Jun. 2018

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).

The Host Institution (PUT) has extensive experience in obtaining and managing European and national projects in cooperation with international partners. In previous years, PUT conducted 29 Seventh Framework Programme projects (6 as a leader), 17 projects within Horizon 2020, and many national ones. The 5 recent projects of particular relevance to this application are:

"Foundations of Trustworthy AI - Integrating Reasoning, Learning and Optimization" (TAILOR), source of financing: European Commission (H2020), PUT team leader: Prof. Krzysztof Krawiec, total budget: €12,000,000 (PUT: €104,000), 2020-2023. The project aims to form a network of research excellence centers for trustworthy AI, combining machine learning, optimization and reasoning, via exercising parallel activities: a fundamental research program on great challenges, a connectivity fund for dissemination to and inclusion of the broader European AI community, network collaboration, and applied research and applications in collaboration with industry. Selected partners (out of 52): **DFKI, INRIA, CNRS, EPFL, Univ. Oxford, TU Delft, Fraunhofer Institute, Jožef Stefan Institute, Philips, Bosch, ABB.**

"Models and techniques for managing the correctness and validity of customer/citizen master data in a large financial institution using self-learning modeling", source of financing: NCBiR, PUT team leader: Robert Wrembel, PhD DSc., Associate Professor. PUT budget: PLN 3,980,000; 2020-2023. The objectives of the project, conducted in collaboration with Poland's largest bank **PKO BP**, are: 1) to build a central repository of integrated bank customer data, 2) to develop methods for deduplication of customer and related data, and 3) to develop models for aging of contact data. Objectives 2. and 3. engage a range of ML approaches and techniques.

"Cancer Patients Better Life Experience" (CAPABLE), source of financing: European Commission (H2020), PUT team leader: Szymon Wilk, PhD DSc., Associate Professor, total budget: €5,962,792 (2020-2023). The aim of the project is to provide assistance to cancer patients who are usually treated at home for a long time after primary intervention. CAPABLE develops a patient coaching system based on clinical management guidelines and predictive models based on clinical data, patient-reported data, and environmental and wearable sensor data. Core partners: **Univ. Pavia, Univ. Haifa, Univ. Politécnica de Madrid, Academic Medical Centre Amsterdam, IBM Israel, Netherlands Cancer Institute and ICS Maugeri.**

"SubTerranean Haptic InvestiGator" (THING), PUT team leader: Dr.-Ing. Krzysztof Walas, source of financing: European Commission (Horizon 2020, GA 780883), total budget: €4,071,685 (2018-2021). The goal of the project is to build a perception and control system for a walking robot to perform inspection tasks in underground objects. Novel contributions include new algorithms for visual and tactile perception that engage unsupervised and weakly supervised ML. Core partners: **Univ. Edinburgh, Univ. Oxford, ETH Zurich, Univ. Pisa, KGHM CUPRUM and ANYbotics (Switzerland).**

"#Webimmunization. How can online social networks create collective resilience against misinformation?", source of financing: Polish-Norwegian NCN IdeaLab program, total budget: PLN 5,667,500 (PUT: PLN 942,738), PUT team leader: Mikołaj Morzy, PhD DSc., Associate Professor. The aim of the project is to use ML and Alto construct tools supporting collective resistance to des- and mis-information in social networks. Partners: **Jagiellonian University (ethics), University of Oslo (psychology), Institute of Pharmacology of the Polish Academy of Sciences (cognitive science).**

3. Available research equipment, apparatus/infrastructure and intangible assets held in the context of implementation of a project regarding artificial intelligence.

The hosting institution (PUT) has in its possession a range of well-equipped research and educational laboratories acquired within past and ongoing projects. The laboratories feature diversified appliances, some of them unique nation-wide, and facilitate both ongoing fundamental research in AI and ML, as well as applications in various areas. The computing resources comprise a total of roughly 500 professional workstations, most of them equipped with deep learning-enabled GPU cards, including workstations with specialized multi-core computing architectures; about 100 of those nodes are integrated into distributed Linux-based computing cluster (Slurm). Other equipment includes **Nvidia DGX Station A100 server for deep learning tasks**, **IBM PureData System for Analytics (Netezza) superserver for BigData applications** (64TB, 120GB RAM, 22 CPU, 120 cores in total), Nvidia embedded platforms, e.g. Jetson Nano, Jetson AGX Xavier, and more. PUT has also extensive state-of-the-art computer network infrastructure and cooperates closely with the Poznan Supercomputing and Networking Center (PSNC).

Atop of those computing resources, PUT maintains laboratories that facilitate research on AI-based physical systems in robotics, biomedicine, human-machine interaction, virtual and augmented reality. Robotics laboratories are among best equipped in Poland, with unique appliances such as the **ANYmal autonomous walking robot** (one of the few such research robots in European universities), an autonomous electric car with a multi-sensor perception system (cameras, LiDARs) and a drive-by-wire system, and a mobile-manipulator robot that allows for bi-manual manipulation. There are also cooperative manipulators (UR-3, UR-5, Kinova), several mobile robots (e.g. Unitree A1 Explorer), and multi-rotor flying robots, including our own designs. All robots are equipped with advanced sensor systems: cameras, 3D (depth) and RGB-D cameras, and 2D and 3D laser scanners. The equipment includes sensors recently introduced to the market, such as 3D/RGB-D Photoneo Motioncam 3D and Kinect Azure cameras, LiDARs (Ouster OS0/OS1 Gen2, Velodyne, Sick), hi-res thermal imaging cameras, as well as the OptiTrack motion capture systems in stationary and portable versions.

The European Center of Bioinformatics and Genomics of PUT has unique equipment that enables AI and ML research in medicine and biology. SkyLab is a specialized laboratory facility in the field of optical observation systems. PUT is also a co-owner of a **testing and experimentation facility** (Kakolewo), which features a test hall (700 m²), dedicated IT infrastructure for collecting and processing of large volumes of sensor data, including data acquired from satellite and aerial imagery systems, and a range of robots, drones and sensors. The facility also offers cars and a light manned aircraft for surveillance missions. The "Aerosphere - airport of things" project (ID: RPWP.01.01.00-30-0001/18) and subsequent investments turned Kakolewo into a modern and unique on the national scale research environment for R&D within AI and ML applications in robotics, autonomous vehicles, unmanned aerial vehicles, image and multispectral data analysis (satellite and airborne imaging) in large-scale agriculture, precision farming, environmental protection and logistics. The testing facility is in line with the concept of **Sectorial Testing and Experimentation Facilities** announced by the European Commission.

The intangible property of the applicant includes numerous software licenses, intellectual rights to data sets used in machine learning (e.g. PUT Face Database) and certificates of laboratories, e.g., Nvidia Deep Learning Institute. PUT is also an institutional member of widely recognized AI-, ML-, and robotics-related international organizations: **CLAIRE**, euRobotics aisbl, Autoware Foundation.

4. Facilities or incentives to establish an AI Centre of Excellence in the entity.

The hosting institution (PUT) declares extensive administrative and organizational support for visitors. In particular, PUT offers free accommodation in high-standard hotel rooms and apartments (1- and 2-bed) in its student residences, which will be available for Ph.D. students coming to the AI Center of Excellence. In addition, PUT will delegate a person from the division reporting to the Vice-Rector for International Cooperation, whose task will be to provide day-to-day assistance to foreign researchers as they settle in Poznan (assistance in renting an apartment, administrative services, help in finding places in a nursery/preschool/school, also with the English language). As part of the training offered under POWER or NAWA programs, PUT offers Polish language courses for foreigners and special courses dedicated to intercultural communication, that are meant to facilitate adaptation of foreigners. PUT will also cover in full two Ph.D. scholarships assigned to the AI Center of Excellence.

PUT's key asset in the field of artificial intelligence are its exceptional **human resources**. The potential of PUT scientists is described in sections 5 and 6 of this application. PUT students are among the best in Poland. In the last four years, PUT students have co-authored 44 scientific publications and presented 25 papers at international scientific conferences, and won many prizes and awards in national and international competitions.

PUT occupies a large, **modern campus** located by the Warta river, within walking distance to the Old Market Square, the historic center of Poznań, and extensive recreational areas (Lake Malta). The Leader will be provided with independent rooms in well-equipped office space on the campus with access to specialized laboratories. The Leader will be included in WliIT's "Grants for grants" programme, which provides financial and administrative support in preparing research proposals, and will receive extensive support of the Faculty coordinator for cooperation with the industry. **Poznań Supercomputing and Networking Center** is also located within the campus, and PUT is cooperating with PSNC intensively - the Leader will be able to join the cooperation and use the infrastructure and support for business applications.

Poznań is in the 8th position in the ranking of European technology cities "EMEA Tech Cities" published by CBRE. In the past 10 years, the employment dynamics in the ICT sector have increased by 64%. At the moment, approximately 25 000 programmers work in 9000 companies in the ICT sector in Poznań. **Many international companies** are located in Poznań, such as NetGuru, Talex, ICEA, Allegro, Komputronik, Capgemini, Cognifide, Roche, Beyond, Egnyte, TomTom. Two clusters, "Wielkopolska ICT Cluster" and ECDF mCluster, and five technology parks provide infrastructure support for ICT initiatives. Dedicated programs support the creation of start-ups as well as sustainable and anti-discriminatory development of the ICT sector. At the moment, there are more than 250 start-ups and over a dozen investment funds operating in Poznań. The Poznań City Hall develops **smart city projects** in, among others, environmental and climate protection, transport infrastructure, citizen safety, open data, and public spaces. There are plans to organize a pilot zone of a super-intelligent city in the city center soon, with PUT's engagement.

5. Other information concerning internationalisation of the entity, foreign scientists employed in this institution, availability of seminars in English, etc.

PUT strongly aims at improving internationalisation of scientific research and student education. In 2020 PUT, as a consortium leader (the only such case in Poland) was awarded the EUNICE (European University for Customised Education) project together with 6 European universities. In the next 3 years EUNICE will intensify exchange of international students, academic staff and development of innovative teaching curricula, also for doctoral studies. Additionally, EUNICE is supported by REUNICE sub-program, which will strengthen international collaboration in research.

As of 2021, PUT employs 26 foreign scientists on a full-time basis. Some of these researchers have already formed international research groups at PUT. For instance, Prof. Francois Beguin (h-index=72), who joined the Faculty of Chemical Technology at PUT in 2011, has been awarded with multiple valuable grants in the last 10 year, including NCN MAESTRO, NCN BEETHOVEN, FNP TEAM TECH, and an indirect effect of his affiliation with PUT was winning of an ERC Starting Grant by one of his younger collaborators. The Institute of Computing Science (II) currently employs two post-doc researchers from Italy and Uruguay under the Marie Skłodowska-Curie Grant EU and Genome Poland projects. By 2020, II also employed 5 full-time foreign researchers, and four PhD foreign students were hosted under the Erasmus Mundus Doctorate (Information Technologies for Business Intelligence program). Moreover, the Institute of Robotics and Machine Intelligence (IRIM) has employed two foreign researchers under the Regional Science and Research Agendas and H2020 THING projects (until 2020). Researchers of PP participated in many scientific exchange programs and international conferences. In 2019, the number of foreign visits was more than 1500 and guest arrivals more than 300. Participation in the Erasmus+ mobility program resulted in 295 training or teaching trips. Many scientific seminars are conducted in English (see, e.g., <http://idss.cs.put.poznan.pl/site/117.html>)

Foreign doctoral students receive versatile support from PUT. There are currently 21 foreigners out of 298 PhD students, and 16 within the newly formed PhD school. The procedure for cooperation with AIDA, i.e. the European doctoral school in AI, has been just initiated. In the Faculty of Computer Science and Telecommunications (WliT), two PhDs theses of foreigners were defended in the last years (2019, 2021) - both directly related to ML. The Faculty also promotes the selection of foreign supervisors and reviewers of PhD Theses (12 in the last 5 years). Joint PhDs in the framework of the double-diploma were implemented (mainly with the University of Luxembourg, Universitat Politècnica de Catalunya, and Vrije Universiteit Brussel).

Since 2021, II and IRIM act as partners within the large European network TAILOR (Foundations of Trustworthy AI - Integrating Reasoning, Learning and Optimization), as the only participant from Poland. TAILOR has been initiated by the European Commission as one of four 'flagships' that are meant to foster and advance the collaboration in AI and ML in Europe. Researchers from both institutes have many joint publications with foreign authors from prestigious universities (see section 6). PUT also participates in the **Digital Innovation Hub in AI** (<https://ai-dih-network.eu>).

PUT offers 21 undergraduate and graduate programs in English, with 419 foreign students currently enrolled (WliT 29% of them). **PUT is the first university in Poland that launched a full-time undergraduate program in Artificial Intelligence in English (in 2019)**. Moreover, IRIM offers first and second degree studies in Automatic Control and Robotics, where the master's degree program, focused on Smart Aerospace and Autonomous Systems, is jointly prepared with a French university. In terms of teaching and student exchange, PUT has over 100 Erasmus+ partnership agreements. In 2019, 419 foreign students arrived in PUT and 259 Polish students traveled abroad.

6. Other significant information confirming the experience and resources of the institution.

Researchers at the ICS and IRMI have extensive experience in collaborating with scholars around the globe, proven by a publication record that includes co-authors from such universities as **Oxford, Stanford, MIT, ETH Zurich, La Sapienza, Torino, Freiburg, Vienna, TU Munich, TU Dresden, TU Eindhoven, EPFL, Université Paris-Dauphine, University of Lisbon, Pompeu Fabra University**. According to the ranking of the Center for Strategic and International Studies, R. Słowiński, J. Błażewicz, and J. Stefanowski from the ICS are the most cited Polish computer scientists in the world (with only eight Polish scientists in the ranking). Stanford's TOP2 ranking, which listed 2% of the most influential scientists in the world in 2019, lists four professors from the Faculty of Computing and Telecommunications. PUT is also the only Polish university (along with the University of Warsaw) listed in the 2019 Shanghai Global Ranking of Academic Subjects in the Computer Science category. Moreover, among its professors, PUT has three winners of the Foundation for Polish Science award, known as the "Polish Nobel prize." PUT researchers are also among the chairs of the Polish Academy of Sciences and numerous international scientific societies. Many of these highly acclaimed scientists are experts in AI, ML, and related fields (robotics, decision support, operational research), and together form the **strongest scientific environment in the country working at the intersection of these fields**, integrated through such organizations as the [Center for Artificial Intelligence and Machine Learning](#). PUT researchers are also co-organizers of many international conferences in the field. For example, in the last five years, PUT organized three prestigious international conferences: the 24th IFIP World Computer Congress (2018), the 28th European Conference on Operational Research (2016), and the 17th Conference on Artificial Intelligence in Medicine AIME (2019). Poznan was also the co-founder and first host of the Polish Alliance for Artificial Intelligence (PP-RAI 2018). PUT scientists were also among general chairs of such AI-related conferences as EURO and ACM GECCO.

Being a technical university, PUT is well prepared to lead applied research projects from fields such as robotics, electrical engineering, civil engineering, transport and aviation, and chemistry. PUT has the staff, experience, and equipment to commercialize technological products from the abovementioned fields. The University has its own academic business incubator, coworking spaces, and a network of industrial partners including Volkswagen, Roche, GlaxoSmithKline, PKO BP, Enea, Emapa, Solaris Bus & Coach, and others, including the Industry 4.0 Initiative. These efforts are aided by a recently-opened applied doctorate program, which currently has 12 Ph.D. students. It is also home to several biomedical projects, which led to the creation of the [European Center for Bioinformatics and Genomics](#), a PUT-based initiative that leads biomedical collaborations with Polish and foreign scientific institutions. PUT also co-creates, with the [Poznan Supercomputing and Networking Center](#), the Digital Innovation Hub [HPC4Poland](#). The will to cooperate within the AI Centre of Excellence at PUT was expressed through a letter of intent by, among others, Poznan City, SpeedUp BRIDGE Alfa VC fund, HCP Medical Center, Industrial Institute of Agricultural Machines - Łukasiewicz Research Network, Solaris, Intel, Roche.

The Institute of Computing Science is a domestic pioneer in AI education. Researchers at the Institute created one of the first university courses on machine learning (since 1997), the first AI undergraduate course taught in English (since 2019), and the postgraduate [AI Tech](#) program (since 2021, to which PUT was invited by the Chancellery of the Prime Minister in the group of 5 universities). These efforts result in a steady flow of new AI specialists. PUT's Ph.D. students won five main prizes (2x2018, 2015, 2014, 2012) and four honorable mentions (2x2015, 2013, 2012) in the Best AI Ph.D. Award of the Polish Artificial Intelligence Society, which is the best result among all the Polish universities.