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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)	*Institute of Bioorganic Chemistry Polish Academy of Sciences* *Poznan Supercomputing and Networking Center*
Name (short)	*IBCh PAS PSNC*
Name of the main organisational unit (where applicable)	*Institute of Bioorganic Chemistry Polish Academy of Sciences* *Poznan Supercomputing and Networking Center*
Address of the registered office	
Street	Zygmunta Noskowskiego
Building No.	*12*
Office No.	*14*
Postal code	*61-704*
City/district	*Poznań*
Post office	*Poznań*

Municipality	*Poznań*
County	*Poznań*
Province	*Greater Poland*
EPUAP [Electronic Platform for Public Administration Services] mailbox	**/ICHB/pcss**
Legal form	**State organisational entity**
The person appointed for contact with NCBR and with the potential Leader/Project Manager	
First name	**Krzysztof**
Last name	**Kurowski**
Position	**Deputy Director PSNC**
Phone number	**61 858 5072**
E-mail address	**Krzysztof.kurowski@man.poznan.pl**
The person authorised to represent the applicant	
First name	**Marek**
Last name	**Figlerowicz**
Function/Position	**Director IBCh PAS**
First name	**Cezary**
Last name	**Mazurek**
Function/Position	**Director PSNC**

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).

Selected results of R&D projects:

PSNC developed voice recognition methods applied to various projects. **AISOK**, automated intelligent customer service system, enables human-computer communication.   **INSENSION** is a platform that supports handicaped people, who has limited ability to communicate. **MediaEstimator** is related to measurements of brand exposure in media.

M. Owsianny, Perceptual Identification of Polish Vowels Due to F0 Changes, in: Archives of Acoustics, 2019, Volume 44, Issue 1, pp. 13-26.

Within the **CATALYST** project, focused on innovative integration of data centers with energy markets, models and prediction tools were produced in order to predict energy consumption and temperature distribution were proposed. Machine learning was used to reduce time needed to provide approximate prediction. This research is continued in the **RENergetic** project, in which the re-use of the waste heat from a data center by a university campus. M. Antal, T. Cioara, I. Anghel, R. Gorzenski, R. Januszewski, A. Oleksiak, W. Piatek, C. Pop, I. Salomie, W. Szeliga, Reuse of Data Center Waste Heat in Nearby Neighborhoods: A Neural Networks-Based Prediction Model, 1996-1073, 12, 5, 2019, DOI: doi:10.3390/en12050814 . **COVID-HUB.** The project concerned the construction of a CoVid-19 diagnostic support system that analyzes chest X-ray images with deep neural networks. A new effective method for dealing with multiclass imbalanced data, called Adversarial OverSampling, has been proposed. The method is specially tailored to medical image data and allowed for obtaining better classification performance. The constructed system achieves 96% precision in the detection of CoVid-19 and over 95% on G-mean measure. Wojciechowski A., Lango M.: Adversarial OverSampling for imbalanced image data classification, MLinPL Virtual Meeting, 2020

Selected results from commercial projects:

Brocade IPA, a project financed by Brocade Communications Systems, where PSNC team deployed Big Data infrastructure, network traffic repositories and implemented a set of Machine Learning and Deep Learning algorithms for DDoS attacks detection in 10G links of the PIONIER network. Processed data volumes included data sent at the speed of monitored network interfaces, i.e. 10 Gbit / s. In the case of continuous monitoring of one network interface, the volumes of processed data reached the magnitude of 75 GB. The project **IVCADA** realised within the ScaleUp programme in the cooperation with Grinfinity and H.Cegielski companies is related to visual inspection of steel elements. This type of inspection, called Nondestructive testing (NDT), includes the following steps: the steel element is magnetization and pouring with dedicated liquid. Then in UV light all kinds of defects on the surface of the element can be observed, e.g. cracks or scratches. The role of PSNC in this commercial project was building the AI model, which could automatically detect all kinds of defects in the NDT images, and integrating the model in production system. Application to the European Patent Office for the invention of **a medical device for diagnosing glaucoma**, based on machine learning technology. In cooperation with a domain expert, a diagnostic model was developed which, based on data from medical devices (24-hour examination of eyeball volume changes and monitoring of cardiovascular parameters) that predicts the risk of glaucoma with high efficiency.

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).

SHOP4CF (Smart Human Oriented Platform for Connected Factories), Adam Olszewski, EU Horizon 2020, 529 500.00 €. SHOP4CF is an EU-funded project within the eighth framework program Horizon 2020. The project aim is to find the right balance between cost-effective automation, repetitive tasks and involve the human workers in areas such as adaptability, creativity and agility where they create the biggest added value. In SHOP4CF, 30 different components are developed by top research and technology organizations from all over Europe. PSNC develops two of them: Predictive Maintenance and Anomaly Detection (PMADAI) and Visual Quality Check (VQC). PMADAI component is being developed in close collaboration with Volkswagen Poznań. The first objective of the component is detection of problems during the car body painting process. The second objective is to support maintenance needs in the painting area. Some of the recent advances in machine learning, and particularly anomaly detection, are applied to meet these objectives. VQC is a component develop for Bosch factory in Madrid. Its goal is to visually analyse assembled printed circuit boards in order to localize defects. To solve this problem standard image processing and deep learning methods are applied.

NEBI (NEuro-BioImaging Poland), Krzysztof Kurowski, POiR 4.2, 215 048 886 PLN.The project NEBI aims to create a National Center of Advanced Imaging Analysis in Biological and Biomedical Sciences. The main role of PSNC within this project is to build an IT infrastructure for data storage and analysis. The platform can be used by partners both from Poland and other countries. PSNC gives support in imaging data processing and analysis, also with Deep Learning based approaches.

ADMIRE (Adaptive multi-tier intelligent data manager for Exascale), Ariel Oleksiak, EU EuroHPC, 550 500.00 €. The project ADMIRE aims to create a software solution that allows HPC systems to maximise performance and avoid bottlenecks in processing extremely large data sets. The role of PSNC in this project is to validate an outcome of project solutions on Deep Learning use case. The goal of the use case is to use superresolution images from microscopes in order to build a Deep Neural Networks (DNN) model for classification of images representing healthy tissues and with neurodegenerative changes. The most relevant feature of this model should not be only distinguishing between two classes, but also indicating the most significant features in the image, that helped the model to make a decision.

"FBC-TENE: Increasing accessibility of digital resources coming from the Polish cultural and scientific institutions in Polish Digital Libraries Federation through the textual and musical contentacquisition.", Tomasz Parkoła, Program Operacyjny Polska Cyfrowa, II E-administracja i otwarty rząd, 2.4 Tworzenie usług i aplikacji wykorzystujących e-usługi publiczne i informacje sektora publicznego, 1 500 388.34 PLN. The aim of the FBC-TeNe project is to increase accessibility of digital resources coming from the Polish cultural and scientific institutions. It will be done by further development of FBC (Polish Digital Libraries Federation, https://fbc.pionier.net.pl/) in the context textual and musical content. The project will use AI mechanisms in tools for text recognition (Optical Character Recognition) and music recognition (Optical Music Recognition). The results of these activities will improve data discovery services of FBC and will give the end-users new ways of accessing Polish cultural heritage and scientific content.

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).

PSNC provides scientific community with advanced computing infrastructure since many years. Currently, PSNC offers two computing clusters Eagle and Altair, providing closely to 100 000 CPU cores in total.

Altair is the most powerful supercomputer in Poland, ranked at 85th position on the TOP500 list of the fastest computers all over the world. Moreover, the cluster is classified on 61st place on the Green500 list of the most efficient computing systems. Hence, AI computing performed at PSNC does not only have good performance but also high efficiency leading to the low carbon footprint. Altair's computing power is close to 6PFLOPS using 63360 cores of Intel CPUs in 1300 computing nodes and 9 test nodes equipped with GPU accelerators NVIDIA V100 (8 per each node).

Computing power of the Eagle's cluster is close to 1.4PFLOPS using 32984 core of Intel CPUs in around 1200 computing nodes and 3 test nodes equipped with GPU accelerators NVIDIA V100 (2 per each node).

Computing resources are managed and made available using the SLURM system with dedicated queues for memory intensive jobs or jobs that require access to GPU accelerator, common in deep learning to guarantee sufficient performance.

Additionally, PSNC is working on the specification of the new computing cluster dedicated, at least partially, to big data processing and AI models. Initial plans assume computing power of the new cluster reaching 25 PFLOPS, half of it delivered by GPU accelerators.

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

In addition to the computing and networking infrastructure PSNC hosts and develops a number of services that provide access to the infrastructure and enable development of new systems and applications.

One of such services is the Platform as a Service (PaaS), which enables flexible management of resources and applications using the containerization technologies. It can be applied to develop, manage and deliver AI-based applications for example either using Jupyter notebooks or dedicated user interfaces.

Another example of services are those being developed within the scope of the PRACE-LAB2 project. They will include services for large scale data analytics and for computing needed for artificial intelligence (AI) scenarios. Services and tools for machine learning will support the whole cycle of preparation and application of AI models, including deep learning methods based on artificial neural networks. These services will support both supervised and unsupervised learning. To achieve required performance and scalability of AI solutions, distributed computing resources with hardware accelerators will be applied. Available methods will include models of artificial neural networks such as CNN, LSTM, GAN or clustering methods such as DBSCAN. Access to popular tools such as TensorFlow, Horovod, SciKit, Keras is provided.

PSNC hires more than 400 IT specialist: programmers, administrators, user interface experts, etc. That allows potential AI leaders to take advantage of professional support in large data processing and development of advanced IT solutions based on AI methods. Additionally, PSNC collaborates with Poznan University of Technology in the framework of the AI DIH Network– a Digital Innovation Hub focusing on applications of artificial intelligence methods. In the scope of this collaboration PSNC takes advantages of AI experts knowledge and the Artificial Intelligence (AI-Tech) students.

At PSNC the ISO 27001 (information security) and ISO 9001 (quality) norms are deployed and confirmed by a certificate of the independent certification authority. Secure data management is supported, which is important aspect of AI methods development.

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

PSNC has a rich history of collaborations in international R&D consortia. It participated in more than 200 projects, coordinating more than 30 of them. Scientific collaboration takes place to large extent in the fields of High Performance Computing (HPC), European Open Science Cloud (EOSC) and Digital Innovation Hub (DIH).Only in 2020 PSNC was running 56 international R&D projects, including 22 in H2020: Excellent Science, 14 in the scope of H2020: Industrial Leadership – ICT, 6 in H2020: Societal Challenges, 2 in H2020: Euratom, 8 in European Partnerships and 4 in CEF/Erasmus/Regional.13 international projects concerned directly HPC area, 3 projects Future and Emergent Technologies (FET) projects funded within Transition to Exascale Computing, 2 Centers of Competence in the area of HPC, concerning exascale applications in the field of ENERGY and GLOBAL SYSTEMS, and 8 projects related to ICT development.

Contribution to such large number of projects allow PSNC to build stable international collaboration with broad network of partners. For example, in 8 ongoing EOSC projects PSNC cooperates with more than 220 institutions, including 5 form Poland. One of these projects is The European Open Science Cloud (EOSC) is an ongoing effort to connect existing European e-infrastructures, integrate cloud solutions and provide a coherent point of access for various public and commercial services. EOSC is going to act as a virtual, distributed repository of research data and related services. Role of PSNC in this project is, among other responsibilities, to enhance the efficient use of the EOSC Portal by enabling user-profile-specific suggestions of useful services identified by machine learning techniques (i.e., a recommendation system which supports the work of researchers by e.g. assisting them in the selection of specific services).

Furthermore, in projects from Digital Innovation Hubs PSNC collaborates with more than 300 partners, 150 being SMEs. Due to the activity in this scope the PSNC's Digital Innovation Hub – HPC Poland was awarded in 2020 a status of i-SPACE Silver. Institutions collaborating with PSNC include other HPC centers such as BSC in Barcelona, HLRS in Stuttgart, CINECA in Bologna, and research center Juelich, big companies such as Volkswagen, Bosch, ATOS, Intel, Siemens, ARM as well as other research institutions or SMEs.

PSNC is also a full member of ig Data Value Association (BDVA)and NVIDIA Deep Learning Institute. It is also a partner of the AI DIH Network, a Digital Innovation Hub (DIH) that concentrates on the artificial intelligence. PSNC also established a collaboration with the European Bioinformatics Institute (EMBL-EBI). In the scope of this collaboration a COVID-19 platform was deployed in PSNC as a national node of COVID-HUB-PL.

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

Apart from R&D activity in large number of international project and commercial cooperation PSNC supports development od AI applications through commitment to expert groups and educational activities.

Expert groups:

In particular dr Krzysztof Kurowski is a member of expert group in Horizon Europe on *AI, data and robotics* and a member of the BDVA community. Many other PSNC employees participate in other groups dedicated to Internet of Things, energy efficiency and climate changes, High Performance Computing (HPC) and others.

Education:

PSNC in cooperation with Intel carried out several pilots of the Intel's programmes dedicated popularization of AI technology within high schools students in Poland and other European countries. PSNC was responsible for adapting courses, training students and teachers in three Intel's programmes: AI for Youth, AI for Youth Express, AI for Workforce.

The aim of the programs is to prepare young people for the advent of the AI revolution to increase employability in the digital age.

Thanks to the courses, teachers and students developed knowledge in the field of artificial intelligence, improved their programming skills, and finally they used the newly acquired skills to solve real social problems with the help of AI technology, with the emphasis of potential technological dangers and awareness of the ethical and social consequences of using Artificial Intelligence.

The role of PSNC in aforementioned programmes includes:
- providing of a dedicated artificial learning cloud platform based on Jupyter notebook
- providing students and teachers with access to a dedicated could learning e-services,
- adapting the content and training materials to European conditions and to on-line/remote (in connection with COVID-19) training model with the use of could based access to Jupyter notebooks ,
- conducting on-site and on-line workshops and providing online support for teachers and students,
- advising teachers and students through e-mentoring,

PSNC has so far conducted:
- two full editions of the AI for Youth course for Polish teachers and students,
- one course for NREN teachers and employees from Germany,
- one edition of AI for Youth Express for teachers in Spain, Italy, Portugal and France,
- one edition of AI for Workforce course for teachers and students of agricultural schools in Poland

In total, training activities covered over 230 teachers, including over 190 from Poland. On May 7th, PSNC signed the contract with Polish Ministry of Economic Development, Labour and Technology for the implementation of a bigger pilot of the AI4Y program in Poland covering 120 teachers and 1800 students across Poland.