sciendo

Artificial Intelligence Research Community and Associations in Poland

Grzegorz J. Nalepa [*], Jerzy Stefanowski [†]

Abstract. In last years Artificial Intelligence presented a tremendous progress by offering a variety of novel methods, tools and their spectacular applications. Besides showing scientific breakthroughs it attracted interest both of the general public and industry. It also opened heated debates on the impact of Artificial Intelligence on changing the economy and society. Having in mind this international landscape, in this short paper we discuss the Polish AI research community, some of its main achievements, opportunities and limitations. We put this discussion in the context of the current developments in the international AI community. Moreover, we refer to activities of Polish scientific associations and their initiative of founding Polish Alliance for the Development of Artificial Intelligence (PP-RAI). Finally two last editions of PP-RAI joint conferences are summarized.

1. Introductory remarks

Artificial Intelligence (AI) began as an academic discipline nearly 70 years ago, while during the Dartmouth conference in 1956 the expression Artificial Intelligence was coined as the label for it. Since that time it has been evolving a lot and developing in the cycles of optimism and pessimism [27]. In the first period research in several main subfields were started but the expectations the founders put were not fully realized. Thus, the disappointments and cutting financing in the 1970s led to the first, so called, AI winter. The research was intensified again in 1980s, mainly with promoting practically useful, narrow purpose systems, such as expert systems, based on symbolic approaches and logic [21]. Nevertheless, they were not so successful as it was expected. Then, important changes in AI paradigms concern non-symbolic and more numerical approaches [1]. During the end of 1980s many researchers focused interests on

---

[*]Institute of Applied Computer Science, Jagiellonian University, and AGH University of Science and Technology, Cracow, gjn@gjn.re

[†]Institute of Computing Sciences, Poznan University of Technology, Poznan, jerzy.stefanowski@cs.put.poznan.pl

methodological inspirations coming from statistics, numerical methods, optimization, decision analysis and modeling uncertainty. It helped in a significant progress in new machine learning methods, rebirth of neural networks, new developments of natural language processing, image recognition, multi-agent systems, and also robotics [11]. Several researchers proposed new approaches to manage uncertainty and imprecision, while others significantly improved genetic and evolutionary computations – which started computational intelligence subfield [10, 7]. All of these efforts led to the new wave of applications, which were far beyond what earlier systems did and additionally boosted the growing interest in AI.

Since the beginning of this century one can observe the next renaissance of the neural networks research, in particular promoting deep learning, and intensive development of machine learning together with appearance of Big Data [33]. Other advances were also done in computer vision, improving perception of intelligent agents which can perform more complex tasks. New ways of interactions with human were also developed in fields of Ambient Intelligence and smart devices [26]. Moreover, robotics benefits from the fast pace of advances in machine learning, computational intelligence, uncertainty representation and handling, decision making, and multi agent systems. A strong improvement of perception in robots supported progress in human - robot interfaces, their understanding and learning [30]. Furthermore successful techniques were introduced in speech recognition, natural language processing, autonomous systems and self-driving cars. The trustworthy, human-center AI systems and explainability are of crucial importance in AI based system, as in this area the decisions made by algorithms may have immediate physical consequences, and may put at risk human health or lives, e.g. in autonomous driving. Concluding, the never seen before peak of hype around artificial intelligence has occurred in the last years.

However this peak is different than previous ones. It is much stronger and touches different recipients than the research communities only. It seems to look "like a storm' changing the world". One can notice that several factors came together in the last decade:

- Several new methods, e.g. deep neural networks, and intensive developments of older approaches led to a scientific breakthrough,

- Appearance of Big Data, where large volumes of data, having different representations, enable several algorithms to be more efficient and surprisingly accurate in solving difficult, real world complex tasks; Big Data is also characterized by other properties such as Velocity, Veracity or other complexities which have opened new research and application perspectives [17],

- Increasingly powerful computers with greater storage and parallel processing become available and cheaper; the easier availability of GPU hardware and computations had a big impact on training of deep neural networks,

- Advances in solving spectacular real life case studies, e.g. self-driving cars, games such as Go, intelligent query answering and NLP in IBM Watson, medical image recognition, Big Data mining, where intelligent systems could achieve accuracy comparable to humans,

- AI techniques were moved from laboratories to industrial practice, which also attracted a wider attention from other communities than academic researchers.

Furthermore real financial investments were made by many commercial companies. It increased the number of real world applications and boosted selling AI-based products, which provided added economical values. Several reports, such as [2, 25], present information showing that the AI sector has become a growing target area for such investments in the last decade. For instance according to [2] private equity investments in AI companies and start-up accelerated from 2016 (e.g. it doubled from 2016 to 2017 reaching 16 USA billion). The reader can also refer to the fifth chapter of [25] for more details on revenues of AI market. These **economical aspects** constitute a large difference to earlier moments of general interest in AI and its opportunities.

Nowadays, many managers, economists, sociologists or administrative officials perceive Artificial Intelligence as a **general – purpose technology** that will revolutionary change the world economy and society. On one side AI applications may improve productivity gain, saving costs and enable better resource allocation. On the other hand, statistical reports of [2] demonstrate that the large scale effects of AI requires investments in a number of complementary inputs (e.g. infrastructure, collected data but also to train a specialized staff).

The last year McKinsey Global AI report [18] provides results of a large survey (over 2360 participants from various companies all over the world) showing nearly 25% increase of AI applications in standard business processes, where in over 50% they significantly reduced costs. Moreover, 63% respondents are seeing growing return from investments (ROI) from the AI adoption. The highest revenue increases are reported most often in marketing and sales while cost decreases most often in manufacturing. This report also shows which AI methods are the most popular in particular domains. Furthermore other pooling results include risk identifications, in particular a limited access to well prepared data, its good quality, along with privacy protection issues. To sum up, nowadays AI is more and more applied in various areas and often produces money returns. One can also informally say that business began to believe in intelligent products.

Besides benefits of applying AI, several people (also coming from sociology, ethics, philosophy or law) are considering **limitations, risks and ethical issues**. While philosophers raise more fundamental questions about what we should do with the fast developing AI systems and robots, what the systems themselves should do, what risks they involve, and how human can control these systems[1] or how to relate them to respecting human rights, democratic values. The researchers from other fields consider other risks or limitations such as threat to privacy, security, safeness, legal responsibility[2]. Changes of human work, replacing or moving people from one to another new job, continuous education and skill development are next elements of **societal AI impacts**.

---

[1] For a brief definition of research on this field and links to main debates the reader can consult the section entitled Ethics of Artificial Intelligence and Robotics inside Stanford Encyclopedia of Philosophy `https://plato.stanford.edu/entries/ethics-ai/`.

[2] Many intensive discussions on so called superintelligence and the problem of human control over so fast developing and more and more powerful AI systems or robots have also been undertaken by researchers coming from various fields - for instance see the summary available in [19].

This raises many public considerations about **regulations** and needs to ensure **trustworthy, human-center AI systems**. In particular it is visible in European Union experts' discussions, working polices and several recent recommendations or white papers. For instance last year the High-Level Expert Group on AI presented *Ethics Guidelines for Trustworthy Artificial Intelligence.* In February 2020 European Commission released a special white paper on AI, which provides their views on the upcoming policy, addresses the risks associated with AI usage, and discusses future regulatory steps on Artificial Intelligence.

From research perspectives it opens several new challenges how to incorporate these recommendations into intelligent systems. Other problems concern **fairness**, **no-discrimination** and avoiding dangers of transferring **biases** into final systems - which are notably important for some types of Machine Learning and gave rise to a new subfield named Fairness ML [3].

Explainable AI (briefly XAI) is next important research challenge following the aforementioned aspects. It refers to postulates that the purpose of AI system, ways of it's working, rationale and decision-making process should be understood by humans [12]. In particular some ML systems, such as deep networks, are so complex that explaining how their decisions are made may be impossible. Model comprehension, transparency, interpretability, fidelity, accountability are examples of many issues studied in this subfield [4]. Designing systems that are sufficiently transparent about decision process and are accountable for their outcomes is critical in several domains [29]. AI systems have to work properly, in a secure and safe manner [2].

Note that working on national or European policies which promotes trustworthy AI systems or providing regulation frameworks is another characteristics of the current interest peak around Artificial Intelligence.

Observing a growing interest in AI, some experts prepared studies on the current state of AI, its future perspectives, and the impact on the society and economy. For instance the reader could consult *One hundred year study on artificial intelligence* from Stanford University [22]. This panel of well recognized experts defined 18 the most important topics covering research, application domains and societal or legal issues.

Moreover there are many other surveys or research on how different categories of people perceive the usefulness or threats of Artificial Intelligence in their everyday life – for instance the reader may consult for recent Edelman AI Survey [9], which reports a questionnaire pooling of the U.S. general public's perceptions of AI and then it compares it with opinions of senior technology executives. More intensive studying **human perspective and AI perception** is again another aspect which makes a difference to earlier stages the in AI history.

Since last few years many reports, manifests, strategies or recommendations have been prepared by experts' group, think tanks, societies, committees or other organizations. Some of them are a basis for national government strategies for developing and applying AI. Cedric Villani's French report is the most well known and influential example of such reports. The reader can refer to [6, 13] for a survey of the most important national strategies. In particular [13] critically reviews the other strategies with respect to Polish research specific characteristics. Furthermore W. Duch in

his popular text [8] discusses needs of Polish researchers for supporting works on AI topics and limitations of the current attempts to prepare a national AI strategy.

The international scientific associations began to be more active and cooperate with various organization and administrative decision makers. **European Association for Artificial Intelligence EurAI** (formerly ECCAI) is the main representative body for the European AI scientific national associations and has become strongly involved in consultations with European Commission on new a European approach to Artificial Intelligence and Robotics. Besides it there are also several recent European initiatives or union of the centers, labs such as:

- CLAIRE – A Confederation of Laboratories for Artificial Intelligence Research in Europe,

- ELLIS – European Lab for Learning and Intelligent Systems,

- euRobotics – the European Robotics Association,

- BDVA – the Big Data Value Association

are active players in actions on the next step in EU to shape and develop an AI Strategic Research and Innovation Agenda for Europe. For instance some of them are now committing to set up an AI Partnership with EU special Public Private Partnership (PPP) which is directed at boosting the industrial uptake of AI and ensuring Europe's world-wide leadership.

This international context opens more Poland oriented questions. Following opinions expressed by such debaters as [8, 13, 28, 32], Polish AI research community is relatively small but it contains several well recognized people. Members of the community authored a high number of papers, played important roles in international societies – see the next chapter of this paper. However, apparently their opinions, knowledge and competences are not sufficiently well used in the current governmental work on the national strategy and potential policy on Artificial Intelligence in Poland.

The main aim of the reminder of this paper is to briefly describe the main AI research areas in Poland and to present the new initiative of founding Polish Alliance for the Development of Artificial Intelligence (PP-RAI). Moreover two last editions of PP-RAI joint conferences will be described.

2.   Research areas in Poland

In last decades research on theory, algorithms and applications of selected subfields of artificial intelligence have been developed by several Polish teams. Although sometimes they are not so extensive as in the leading countries, some authors evaluate them as more significant than in other areas of computer science and related disciplines - see e.g. [28, 16, 32, 20]. Based on the above mentioned reports, several important research areas, where Polish AI researchers have well established work, and significant results can be identified. These include:

- machine learning methods and systems in a broad sense,

- symbolic knowledge engineering and automated reasoning,

- computational intelligence methods aimed at modeling of complex problems,

- decision support methods and systems.

The above mentioned AI areas are often related with other research disciplines such as, robotics, human-computer interaction, computer linguistics, biomedical engineering, and medical computer science, to name just a few. An especially important and flourishing area of research that also finds many applications is related to image recognition, processing and understanding, and more generally to machine vision, see the report [16].

In the area of machine learning as well as data mining, some of the most important works include:

- constructing various types of classifiers, including complex input and output data, multi-label or difficult multi class tasks, class imbalances, structured outputs, ordinal classification, semantic relationship modeling, uplift modeling; also covering hybrid or ensemble architecture,

- online learning and mining data streams, including clustering and prediction, as well as concept drift,

- network analysis using complex graph models, including social network analysis,

- feature engineering and selection in large data sets, e.g. of biomedical data,

- discovering symbolic knowledge representations from data, mainly rules,

- handling of incomplete and uncertain data, as wall as data granularization,

- preference learning and their modeling in decision support.

In the area of knowledge engineering the most important works concern:

- knowledge representation and modeling, including semantic methods such as ontologies, as well as knowledge management,

- analysis of knowledge quality, including formal verification, inconsistent knowledge handling,

- improving methods of automated reasoning, e.g. in distributed reasoning networks,

- declarative programming, and logic programming.

An important and well represented area of research is related to computational intelligence, and soft computing where works are related to:

- analysis of uncertainty and vagueness of knowledge,

- use of evolutionary methods and other biologically inspired computing paradigms in optimization problems,

- automatic program synthesis by means of genetic programming

- development of hybrid fuzzy and neural systems,

- the development of the rough set theory and its applications[3].

Active research has been conducted in many groups in Poland in the area of decision support, including:

- multi agent systems and multi agent decision support,

- multi criteria decision support with rule models,

- rule-based systems for expert knowledge modeling,

- modeling of agent preferences also with uncertain knowledge,

- recommendation systems and user profiling.

Other important specific areas of work, some of them quite recent, include:

- natural language understanding, speech processing and synthesis, including Humanized InTerfaces (HITs),

- intelligent image processing methods and computer vision, oriented on image understanding, and often related to applications such as robotics or medicine,

- meta-learning,

- computational social choice and game theory

- affective computing including human emotion detection and understanding,

- methods of AI in games both in the theoretical area of general game playing, as well multidisciplinary games modeling and analysis, and finally

- neurocognitive systems.

Furthermore robotics pushes the AI or ML research towards adopting its methods to solving problems in such categories as

- perception: understanding of space, semantics and situations,

- learning and decision-making under uncertainty,

- human-robot interaction and communication.

---

[3]Rough set theory, introduced by Z.Pawlak [23], has been an original proposal which significantly contributed to the international research and inspired a lot of works, also in related fields, see e.g. [31]

The specific application-related problems solved by Polish researchers within this agenda include grasping of previously unknown objects, learning from human demonstration, reinforcement learning applied to sophisticated systems (e.g. legged robots, humanoids), extended autonomy in real-world settings, machine learning in robotic vision, human-robot interaction, selected aspects of autonomous driving, multi agent systems [15].

Another view on research productivity could be done by analyses of publications records using bibliographic databases. To best of our knowledge there is one limited study of bibliographic entries with respect to AI done by OPI Research Institute [24]. It covers publications of scientists hired in Polish research institutions or universities from 2013 - 2020, which were stored in the special database called PBN[4]. Their statistics are surprisingly optimistic, as OPI team discovered in this database nearly 7.300 publications co-authored by approx. five thousands of scientists, which were labeled with terms related to artificial intelligence.

However, this result seems to be over-optimistic and not so methodologically strong. Getting an extra information on methodology of this bibliographic survey, we learn, that all entries in PBN were searched with a list of around 200 keywords (which should cover quite wide spectrum of basic terms from machine learning, data mining, artificial intelligence, image processing, computer vision and human computer interaction). Publications were selected as relevant if at least one of these keywords occurred in the title or the abstract. This way of information retrieval maybe seen too wide. The database repository has a quite specific characteristics designed for reporting aims. What is more important it covers 5 years only (due to needs of, so called, unit categorization). Unlike classic bibliographic repositories, it does not cover many important sources like top conferences, etc. Thus, unfortunately this general part of report may lead to definitely over-optimistic interpretations.

The other part of [24] presents a deeper re-filtering of these publications narrowed to (1) impact factor journals from machine learning, artificial intelligence and data mining; and (2) authors with affiliations representing computer science disciplines. As a result 1662 journal articles with 1,2 thousand of co-authors were identified. The summary table at page 30 of [24] provides a list of institutions with the highest number of publications. Extending it for other positions in this table, we can evaluate around 600 active writing scientists in the main 10 institutions. This may be more realistic number, although still a bit overoptimistic estimation.

The reader can also found in report [24] other additional information on the number of publications per authors, their age, and the very interesting plot presenting a relation between top journal papers vs. other publications (page 40). Another not obvious result includes main keyword statistics in these publications. Besides typical ML or AI words, this chart highlights the following ones: fuzzy sets or logic, rough sets, genetic algorithms, evolutionary algorithms, decision support systems and image processing.

An analysis of citations of the publications is another factor characterizing re-

---

[4]Polish Scientific Bibliography – Polska Bibliografia Naukowa. It is a part of POL-on system used by Ministry of Science and High Education to collect reporting data on publication records submitted by research and teaching institutions for their evaluation, categorization and granting funds

searchers' visibility. Unfortunately such study was not provided for the Polish community. We may refer to *Guide2Research* web service covering the most cited international researchers in computer science (which should have H-index over 40 in Google Scholar and over 100 publications registered in dblp service). According to its latest 2020 yearly report[5] - 7 scientists with Polish affiliations are listed. Six of these seven authors have research results within or closely related to artificial intelligence. Some emigres, like Witold Pedrycz or Jacek Zurada, are assigned to other country rankings. Nevertheless, if one can compare this number to other leading countries in Europe (e.g. 275 researchers in Germany, 171 in Italy, 144 in France, 130 in Netherland, 89 in Spain, 83 in Belgium, 44 in Greece), the citation position of Polish community is much smaller and similar to countries like Czech or Luxembourg.

Some of Polish AI researchers are distinguished by awards and special titles. Janusz Kacprzyk in his lecture [13] presents the basic statistic from 2018. In particular J. Kacprzyk, A. Skowron and S. Matwin were awarded as EurAI Fellows (previous ECCAI Fellows). Among 18 Polish IEEE Fellows 9 are associated with AI and related fields. Within IEEE Computational Intelligence Society two Polish and two emigres professor received special awards for pioneering research - which is the highest number among previous Central – Eastern countries. Moreover few researchers, like J. Kacprzyk or R. Słowiński, are foreign members of Academies of Sciences.

Nevertheless, some other authors present less optimistic opinions. Referring to the aforementioned arguments, the number of these outstanding and internationally recognizable researchers is quite small, as for instance it was discussed in [14, 32]. In particular Przemysław Kazienko in his report entitled in a meaningful way as "We need ambitious researchers and projects " [14] claims that key issues limiting AI research in Poland are the following:

- Still too small number of researchers working intensively in AI and related fields in Poland,

- Too few foreign professors with high impact research results, postdocs and Ph.D students visiting for longer stays and working at Polish universities and too limited cooperation with well known foreign AI centers (here he refers to some informations on numbers of joint publications in recent years and special exchange grants funded by NCN and similar institutions; they are not so well exploited as in other disciplines)

- Nearly no participations of Polish teams in large EU and other international grants (he provides statistics of few or no any projects in different categories such as H2020, ERC3, CHIST-ERA or NATO ones)

- Poor visibility of Polish researcher's articles abroad (again the reader may find a summary of acceptance of Polish affiliation papers at the top conference ACM SIG KDD, NIPS, IEEE ICDM and ECMLPKDD and main AI/ML Data Mining journals which looks pessimistic - quite similar information the reader may also find in [32])

---

[5] Guide2Research in Computer Science – the ranking is based on h-index, citations and number of DBLP documents gathered by May 16th 2020, see `http://www.guide2research.com/scientists/PL`

- Poor inter-disciplinarity of research, which is not well supported by the current state research granting and evaluation system

- Weak or non-existing cooperation between research centers or teams in Poland

- Too few PhDs developed in Artificial Intelligence

Similarly to others he notices that currently in Poland there are many gifted students or young excellent programmers of web, games, ERP or other IT systems. However, only few such talents manage to be directed towards more ambitious projects, including artificial intelligence projects. This is somehow reflected by the number of PhD theses submitted each year to the National Competition organized by Polish Artificial Intelligence Society (PSSI)[6]. In the 10 year history of this Ph.D competition started and led by Stanislaw Matwin, the highest numbers of winners go to the following places (the ranking ordered with respect to the number of main awards, than the number of distinctions): Poznan University of Technology, Warsaw University, Wroclaw University of Technology, Warsaw University of Technology, AGH Science and Technology University, Gdansk University of Technology, and Silesian University of Technology, equally with PAN System Research Institute and PAN Institute of Computer Science, Polish Academy of Sciences.

To sum up, Polish AI research community represents some opportunities but also weaknesses or institutional limitations, what leads some communities to starting new forms of co-operations, which will be discussed in the further sections.

3. Founding Polish Alliance for the Development of Artificial Intelligence

There are five scientific associations in Poland devoted to artificial intelligence or related research fields:

- PSSI - Polish Artificial Intelligence Society,

- PTSN - Polish Neural Network Society,

- SIGMPL - Polish Special Interest Group on Machine Learning,

- Polish Chapter of the IEEE Systems, Man, and Cybernetics Society,

- Polish Section of IEEE Computational Intelligence Society.

Recall that Polish Artificial Intelligence Society (abbrev. as PSSI), founded in 2009, is the main organization in Poland, which aims to promote popularization, development, and applications of artificial intelligence methods and tools. Since 2010 it is a member of the European Association for Artificial Intelligence EurAI (formerly ECCAI). It also belongs to several international alliances for innovations, such as

---

[6]The reader is referred to `pssi.org.pl/pl:konkurs` for more details and results of previous editions

EAI, or CLAIRE. Due to such roles PSSI was early enough involved in discussions of European Commission's coordinated plans for Artificial Intelligence made in Europe.

On the hand Polish Neural Network Society is an older organization, established in 1995, and gathers researchers interested in artificial neural networks, or related soft computing fields. This society has made a strong contribution to starting Polish important conferences such as Neural Networks and their Applications (the first edition in 1994 in Kule / near Częstochowa), which were later, transformed into well-recognized international annual conferences on Artificial Intelligence and Soft Computing ICAISC[7].

Polish Special Interest Group on Machine Learning is less formal light organization, which integrated various Polish groups and individual researches interested in machine learning and data mining. It succeeded to organize several low-cost meetings and seminars or special training events for young Ph.D students and researchers.[8]

Two other sections of IEEE are also very active with co-organizing conferences, including support for more visible international events, such as IEEE Students and Young Professionals Meet-ups or INISTA 2017 - 2017 IEEE International Conference on INnovations in Intelligent SysTems and Applications.

Nevertheless these societies gather slightly different communities and historically they were acting independently and did not intersect, as it could be more profitable. Then, the single organizations are of a medium size as they do not have so high numbers of members as foreign associations. One can also say that external visibility of the research Polish group is not so strong as it could be. This also corresponds to an insufficient identification of partners to talk about the role of Artificial Intelligence and plans of its application by state administration or government officials. Furthermore since many years there have been needs for organizing the big, main national conference on AI in Poland. The existing conferences did not sufficiently fulfill these expectations.

Taking into account these motivations, European Commission's recent activities on new projects and plans concerning Artificial Intelligence, Big Data and Robotics as well as an increasing interest in research and applications of intelligent systems, the main representatives of the aforementioned associations started in the spring of 2018 to talk about joining their efforts in order to better integrate and represent Polish AI research community.

As a result of these discussions they decided to found a new union of these associations, which was further named Polish Alliance for the Development of Artificial Intelligence (abbreviated as PP-RAI / the Polish name – Polskie Porozumienie na Rzecz Rozwoju Sztucznej Inteligencji).

Following further declarations and the signed agreement of the alliance the main aims of PP-RAI are the following:

- to better integrate Polish researchers interested in Artificial Intelligence and related sub-fields,

- to provide a forum for the sharing, exchange, presentation and discussion of

---

[7]ICAISC is organized each year in Zakopane; for more details see `www.icaisc.edu`
[8]See their list at `www.cs.put.poznan.pl/sigml`.

original research results in different areas of artificial intelligence. This should lead to establishing a new regular national Polish conference on Artificial Intelligence under the co-ordination of PP-RAI steering committee,

- to create a platform for a discussion of the new forms of organization and co-operation of research teams, reference to the international growth of interest in AI and pointing the strategic directions of research and applications, including interdisciplinary areas,

- to represent Polish research community for outside partners and indicate needs for changes in cooperation of the scientific community with business partners and state research institutions.

In particular, the founders of Polish Alliance for the Development of Artificial Intelligence stressed the need for organizing a new national conference sufficiently well corresponding to other well established international conference such as AIIA (International Conference of the Italian Association for Artificial Intelligence), CAEPIA (the conference of the Spanish Association of Artificial Intelligence), PFIA (French Plateforme Intelligence Artificielle), AIxIA (Franco-German conference Artificial Intelligence meets Intelligence Artificielle), the German conference on Artificial Intelligence (abbreviated KI for "Künstliche Intelligenz") and even highly prestige ones like AAAI conference (organized by US Association for the Advancement of Artificial Intelligence). In the founders' opinion it was high time to launch similar conference series in Poland dedicated to research on theory and applications of intelligent systems. However due to distributed communities and various association specific characteristics they decided to choose a joint conference forum based of the founding and supporting organization. It was partly inspired by very good experiences of joint conferences such European Conference on Data Analysis (ECDA) or German DAGStat meeting – which stands under the motto *"Statistics under one umbrella"*[9]. It includes several national and also international societies or organizations in one meeting and provides a joint platform for their discussions and activities.

The first PP-RAI meeting was organized in October 18-19, 2018 in Poznan at the conference center of Poznan University of Technology. Besides the five PP-RAI founding associations it was extra supporting by the other following organizations:

- IEEE Robotics and Automation Society Polish Section,

- Network Science Society (Polish Chapter),

- Polish Association for Image Processing (TPO),

- Polish Node of International Neuroinformatics Coordination Facility,

- Societas Humboldtiana Polonorum.

The strategic vision and program of this PP-RAI'2018 meeting was coordinated by the committee including: Ireneusz Czarnowski (Gdynia Maritime University),

---

[9]It could be a nice informal lead phrase for "Polish AI under one umbrella"

Włodzislaw Duch (Nicholas Copernicus University), Krzysztof Dembczyński (Poznan University of Technology), Janusz Kacprzyk (IBS Polish Academy of Sciences, Warsaw), Jacek Koronacki (IPI Polish Academy of Sciences Warsaw, Jacek Mańdziuk (Warsaw University of Technology), Grzegorz J. Nalepa (Jagiellonian University, AGH University of Science and Technology), Leszek Rutkowski (Czestochowa University of Technology), Jerzy Stefanowski (General Chair, Poznan University of Technology), Dominik Ślezak (Warsaw University), Michał Woźniak (Wroclaw University of Science and Technology); additionally supported by Krzysztof Krawiec and Piotr Skrzypczyński (both Poznan University of Technology).

There were 150 registered participants, unfortunately due to logistic resource limits the other potential participants had to be rejected. Besides researchers or industrial participants, the Secretary of State in Ministry of Science and High Education dr Piotr Dardziński, the representatives of Ministry of Digital Affairs (mec. Robert Kroplewski) and Ministry of Entrepreneurship and Technology (dyr. Jan Staniłko), the deputy director of the National Centre for Research and Development (prof. A. Nawrat) also attended PP-RAI 2018 conference. These and other invited guests contributed to special panel discussions on various organization and government aspects of strategic plans for development Artificial Intelligence research and applications in Poland, and possibilities of supporting research communities by extra new initiatives. Conference sponsors were Institute of Computing Science, Poznań University of Technology, Microsoft Poland, TomTom Poland, and TIDK company (Poznan). More information on PP-RAI'2018 conference, its program materials with abstracts, pdf slides of invited lectures and photos are available at `pp-rai.cs.put.poznan.pl`

PP-RAI' 2018 program was organized into invited lectures, several discussion panels, special industrial session and poster presentations. Topics of discussion included, among others:

- International context of Artificial Intelligence and Polish contribution,

- Financial aspects of supporting research on intelligent systems in Poland,

- Artificial intelligence in robotics and control engineering,

- Society in loop – human aspects in AI,

- The current state of Polish AI research group – opportunities and perspectives,

- Business view on AI and relation of applications to academia.

The summary of the conference and discussions is provided in a special report [5][10]. It also contains a list of recommendations for further development of Artificial Intelligence in Poland and potential role of research community.

Furthermore, during the conference the presidents and members of the executive boards of all five associations signed the cooperation agreement to boost the AI development in Poland. In order to more effectively cooperate and to react to various challenges they founded the Board of Polish Alliance for the Development of Artificial Intelligence which contains 9 representatives of all the signatories.

---

[10]it is free available at `pp-rai.cs.put.poznan.pl/pp-rai-2018-raport.pdf`

The members of this Board and their cooperators took part in several consultations and prepared documents for various Ministries. In these documents they stressed needs for new solutions in three areas:

- Establishing and supporting a network of leading research teams

- Implementing new large national research and applied programs

- Creating new opportunities for educating students in Artificial Intelligence or related disciplines and its applications to various other disciplines

In particular they prepared a project of new elite Ph.D. studies on artificial intelligence, which could form good human resources both for academia and applications. Unfortunately it has not been implemented yet.

Finally, the PP-RAI Board plays a steering role to support organization of next Polish Conference on Artificial Intelligence conferences. Up to now it has resulted into:

- 2nd PP-RAI conference was held on October 16-18, 2019 in Wrocław (organized by Wroclaw University of Science and Technology)

- 3rd conference is planed during October 2020, Gdynia; Due to Covid pandemia it was postponed to October 2021, Gdynia (organized by Gdynia Maritime University team)

4. PP-RAI 2019 Conference and selected paper contributions the special issue

The last edition of PP-RAI conference was organized by prof. Michał Woźniak and his co-operators at Wroclaw University of Science and Technology in October 16-18, 2019. In summary, the following 4 plenary talks were delivered during three days of conference:

- New applications of machine learning to multimedia technology by prof. Andrzej Czyżewski from Gdansk University of Technology.

- Learning binary image representations and the path towards 3D by dr Tomasz Trzciński from Warsaw University of Technology

- Multi-winner elections: algorithms and experiments by prof. Piotr Faliszewski from AGH University of Science and Technology.

- AI in Network Science: challenges and opportunities by prof. prof. Bolesław Szymański from Rensselaer Polytechnic Institute, USA.

More than 100 accepted papers have been presented during the following scientific tracks:

- AAI (Advances in AI and related areas)

- Young.AI (session for young researchers)

- CV (computer vision)

- RAS ((R)obotics and (A)utonomous (S)ystems)

- NLP+ASR+CAI (natural language processing, automatic speech recognition, and conversational AI)

- KE (knowledge engineering)

- NI (neuroinformatics)

- ML (machine learning)

- PS+O (problem solving and optimization)

- UAI (uncertainty in artificial intelligence)

The conference proceedings include over 400 pages and as an open access pdf format are available via the WWW page [11]. Furthermore five discussion panels covered issues of AI influence on society and industry, the international visibility of Polish AI researchers, links between quantum computing and machine learning, business perspectives with respect to researchers, Polish ecosystem for developing research. More information on the conference and photos are available at `pp-rai.pwr.edu.pl`.

The members of the program committee and track chairs selected few best papers, which were further invited to this special issue of Foundations of Computing and Decision Sciences Journal. These papers contained in this special issue are improved, and extended versions of the conference presentations. The results have been described more comprehensively, in a wider context of the related work and often included new results, taking into account the outcome of the discussions at the conference. All contributions were subjected to the regular FCDS review procedure. Finally, after rigorous reviewing and revision four papers were accepted for the special issue:

- Andrzej Brodzicki, Michal Piekarski, Dariusz Kucharski, Joanna Jaworek - Korjakowska and Marek Gorgon: "Transfer learning methods as a new approach in computer vision tasks with small datasets"

- Jedrzej Potoniec: "Mining Cardinality Restrictions in OWL"

- Daniel Szostak, Krzysztof Walkowiak: "Application of machine learning algorithms for traffic forecasting in dynamic optical networks with service function chains"

- Mateusz Zaborski, Michal Okulewicz, Jacek Mandziuk: "Analysis of model-based optimization enhancements in Generalized Self-Adapting Particle Swarm Optimization framework"

---

[11] See `pp-rai.pwr.edu.pl/PPRAI19_proceedings.pdf`.

Acknowledgment

5. Concluding remarks

In this short paper we reported on some recent developments in the Polish Artificial Intelligence community. We focused on the actions of the leading AI societies, as well as the creation of the uniting PP-RAI initiative. Several important research areas well represented by the Polish scientists were also indicated. We put this discussion in the context of the important rise of interest in Artificial Intelligence worldwide, as well as the current advancements in this area. Apparently, what we are currently witnessing is not just another "AI hype". Instead, in the last decade we have seen true scientific horizontal breakthrough in Artificial Intelligence . Furthermore, one can observe an authentic commercial and industrial commitment to not only apply the research results, but often supporting scientific investigation. This makes us believe, that it is a perfect timing for the international and Polish AI community to integrate, work together and use this opportunity to improve Artificial Intelligence even further.

References

[1] Aggarwal, A., *Resurgence of Artificial Intelligence during 1983-2010*, available at `www.scryanalytics.com/articles` January 2018.

[2] *Artificial Intelligence in Society*, OECD Publishing, Paris, 2019, `https://doi.org/10.1787/eedfee77-en`.

[3] Barocas, S., Hardt, M., Narayanan, A., *Fairness and machine learning. Limitations and opportunities.* Online textbook `http://www.fairmlbook.org` 2020.

[4] Bibal, A., Frenay, B.: Interpretability of machine learning models and representations: an introduction. *Proceedings of ESANN* 2016, 77–82, 2016.

[5] Czarnowski I., Krawiec K., Mandziuk J., Stefanowski J., Report from the First conference of Polish Alliance for the Development of Artificial Intelligence, PP-RAI 2018, In Polish, Raport z pierwszego Zjazdu Polskiego Porozumienia na

Rzecz Rozwoju Sztucznej Inteligencji PP-RAI 2018 available at `pp-rai.cs.put.poznan.pl/pp-rai-2018-raport.pdf`, November 2018.

[6] *Review of Artificial Intelligence Strategies in the World*, (In Polish – Przeglad Strategii Rozwoju Sztucznej Inteligencji na Swiecie), Digitalpoland Warszawa 2018.

[7] Duch, W., What is Computational Intelligence and where is it going? In: Duch W., Mandziuk J. (eds) Challenges for Computational Intelligence. Studies in Computational Intelligence, vol 63. Springer, 2007.

[8] Duch, W., Artificial Intelligence – Poland's chances, (In Polish Sztuczna inteligencja - szanse Polski), *Sprawy Nauki*, December 2019.

[9] *Edelman AI Survey* 2019. The survey comparing the U.S. general public's perceptions of AI with those of senior tech executives, `www.edelman.com/sites/g/files/aatuss191/files/2019-03/2019_Edelman_AI_Survey_Whitepaper.pdf` 2019.

[10] Engelbrecht, A.: *Computational intelligence. An introduction*, Wiley, 2007.

[11] Flasinski, M., *Introduction to Artificial Intelligence*. Springer 2016 (based on the translation from Polish language edition: Wstep do sztucznej inteligencji, PWN 2011).

[12] Guidotti, R., Monreale, A., Ruggieri, S., Turini, F., Giannotti, F., Pedreschi, D.: A Survey of Methods for Explaining Black Box Models, *ACM Comput. Surv.*, Vol. 51, Nr 5, Article 93, 2018.

[13] Kacprzyk, J., An international context of artificial intelligence expectations and its influence at the Polish research community, [In Polish], An invited lecture at PP-RAI 2018 conference, available at `pp-rai.cs.put.poznan.pl/program/pp-rai-2018-jerzy-kacprzyk.pdf`, November 2018.

[14] Kazienko, P., *We need ambitious researchers and projects* (In Polish as Potrzebujemy ambitnych badaczy i projketow) OPI Portal sztuczna inteligencja, available at `www.sztucznainteligencja.org.pl/potrzebujemy-ambitnych-badaczy-i-projektow/` 2019.

[15] Kopicki M. S., Belter D., Wyatt J. L., Learning Better Generative Models for Dexterous, Single-View Grasping of Novel Objects, The *International Journal of Robotics Research*, 38(10-11), 1246–1267, 2019.

[16] Krawiec, K., *Artificial intelligence in the world of images* (In Polish as Sztuczna inteligencja w swiecie oprazow), OPI Portal sztuczna inteligencja, available at `www.sztucznainteligencja.org.pl/sztuczna-inteligencja-w-swiecie-obrazow/` 2019.

[17] Japkowicz, N. Stefanowski, J. (eds.), *Big Data Analysis: New Algorithms for a New Society*, Studies in Big Data, Vol. 16, Springer, 2016.

[18] McKinsey *Global AI survey: AI proves its worth but few scale impact*, available at `www.mckinsey.com/featured-insights/artificial-intelligence/global-ai-survey-ai-proves-its-worth-but-few-scale-impact` November 2019.

[19] Muller, V. C. Bostrom, N., Future progress in artificial intelligence: A Survey of Expert Opinion. In Vincent C. Muller (ed.), *Fundamental Issues of Artificial Intelligence*, Springer, 553 – 571, 2016.

[20] Nalepa G.J., Ślezak D., Stefanowski J., *Opinia Rady Naukowej Polskiego Stowarzyszenie Sztucznej Inteligencji dla Ministerswa Cyfryzacji z dn. 07 czerwca 2018 r.*, [in Polish] PSSI, 2018.

[21] Nilsson, N.J., *The quest for artificial intelligence. The history of ideas and achievements*, Cambridge University Press, 2010.

[22] *One Hundred Year Study on Artificial Intelligence* Report of the study panel. Stanford University, available at `ai100.stanford.edu` September 2016.

[23] Pawlak, Z., *Rough sets. Theoretical aspects of reasoning about data*, Kluwer, 1991.

[24] *Polish AI Researchers and their publications.* (In Polish as Badacze SI i ich publikacje, Raport OPI), Information Processing Centre - OPI Institute, available at `www.sztucznainteligencja.org.pl/sztuczna-inteligencja-w-polskiej-nauce-2013-2018/` Warszawa 2019.

[25] Perez J. A., Deligianni, F., Ravi, D., Yang G., *Artificial Intelligence and Robotics* UK-RAS White Paper Series on Robotics and Autonomous Systems, 2018; available at `www.ukras.org/wp-content/uploads/2018/09/UK_RAS_wp_AI_web.pdf`.

[26] Ramos, C., Augusto, J.C., Shapiro, D., Ambient Intelligence – the next step for artificial intelligence, *IEEE Intelligent Systems*, vol. 23, 15–18, 2008.

[27] Russell, S. J., Norvig, P., *Artificial Intelligence: A Modern Approach* (3nd ed.), 2009.

[28] Rutkowski L., Who deals the cards in Polish AI. [In Polish], OPI Portal sztuczna inteligencja, Report available at `www.sztucznainteligencja.org.pl/polska-w-swiecie-si/`, 2019.

[29] Samek, W., Montavon, G., Lapuschkin, S., Anders, C., Muller K.R., Toward Interpretable Machine Learning: Transparent Deep Neural Networks and Beyond. Preprint arXiv:2003.07631, 2020.

[30] Skrzypczynski, P., Kornuta, T., Preface to the special issue on recent progress in 3-D visual perception of robots. *Foundations of Computing and Decision Sciences*, 42(3), 179–182, 2017.

[31] Slowinski, R., Greco, S., Matarazzo, B. Rough sets in decision making. In *Encyclopedia of complexity and systems science*, Springer, 7753–7787, 2009.

[32] Stefanowski, J., *A handful of leaders don't make spring* (in Polish as Garstka liderow nie czyni wiosny) OPI Portal sztuczna inteligencja, Report available at `www.sztucznainteligencja.org.pl/garstka-liderow-wiosny-nie-czyni/`, 2019.

[33] Stefanowski, J., Krawiec, K., Wrembel, R., Exploring complex and big data. *International Journal of Applied Mathematics and Computer Science*, 27(4), 669-679, 2017.