



## THE WARSAW UNIVERSITY OF TECHNOLOGY

### **Resolution No. 2/2023 of the Scientific Council of the Research Centre for the Priority Research Area Artificial Intelligence and Robotics of 27 November 2023**

#### **on the announcement of the SzIR-PN programming and scientific competition as part of the implementation of the “Excellence Initiative – Research University” programme at the Warsaw University of Technology**

Under § 7 section 2 items 2 and 3, pursuant to § 4 section 2 item 6 of the Regulations for Research Centres for Priority Research Areas (POBs) of the Warsaw University of Technology, constituting an annex to the PW Rector’s Decision No. 38/2020 of 26 February 2020 on establishing Research Centres for Priority Research Areas (POBs) as part of the implementation of the “Excellence Initiative – Research University” programme at the Warsaw University of Technology, it is resolved as follows:

#### § 1

1. The “SzIR-PN” programming and scientific competition, hereinafter referred to as the “SzIR-PN” competition, is announced as part of the implementation of the “Excellence Initiative – Research University” programme at the Warsaw University of Technology and as part of the implementation of the development strategy of POB SzIR.
2. The SzIR-PN competition shall be conducted under the principles specified in the Regulations for the SzIR-PN competition, hereinafter referred to as “Regulations”, constituting an annex to the Resolution.

#### § 2

1. The competition referred to in § 1 shall be announced on 27 November 2023.
2. The closing date for registration of teams participating in the competition shall be 4 January 2024.
3. The closing date for sending a description of the proposed solution shall be 28 February 2024.
4. The closing date for sending competition entries shall be 15 May 2024.
5. The SzIR-PN competition shall be settled by 20 June 2024.

#### § 3

The Resolution enters into force upon adoption.

Chairperson of RN CB POB  
Artificial Intelligence and Robotics

Professor Cezary Zieliński

**Legally and formally accepted by**

Edyta Olszewska

Legal Advisor for BOP 5694



## **Regulations for the SzIR-PN competition of the Research Centre for POB Artificial Intelligence and Robotics**

### § 1.

1. The SzIR-PN competition aims to popularise research on the use of artificial intelligence and machine learning methods to solve computer vision problems that require the ability to reason abstractly, create analogies, and discover rules.
2. The competition task is to solve the so-called Raven's matrices, which are one of the widely used types of intelligence test tasks (IQ).
3. The competition will be conducted using a dedicated dataset prepared specifically for the competition. A detailed description of the competition task is presented in Annex No. 1 to the Regulations.
4. The SzIR-PN competition shall be financed from the funds of POB Artificial Intelligence and Robotics.
5. The SzIR-PN competition shall concern the development of an IT product created by a team of up to three students of the Warsaw University of Technology.
6. The team referred to in section 5 shall submit a description of the solution concept by 28 February 2024, and the product and report in the form of a draft of a scientific publication in AAAI conference format by 15 May 2024, hereinafter collectively referred to as the "competition entries".
7. The competition entry must meet the following requirements:
  - 1) It should develop an innovative method dedicated to solving Raven's matrices.
  - 2) It should be a prepared draft of the publication in AAAI conference format including a detailed technical description of the prepared solution specifying the differences as compared to the existing methods in the literature, among other things.
  - 3) It should be an evaluation of the quality of the model based on the public part of the prepared dataset, which will be made available during the inaugural meeting of the competition.
  - 4) It should be saved in a specific format allowing evaluation based on the private part of the prepared dataset, which will not be accessible to the participants of the SzIR-PN competition during its duration. The evaluation based on the private part shall be conducted by an evaluation committee (jury of the competition). Details of the required format shall be presented at the inaugural meeting.

### § 2.

1. Applicants may be exclusively students of the first- and second-cycle full-time degree programmes of the Warsaw University of Technology who form a team consisting of a maximum of three students.
2. The team, referred to in section 1, shall apply for the SzIR-PN competition indicating its head, selected from among the team members, and its mentor, selected from among the academic staff of the Warsaw University of Technology, included in the so-called N-number at the Warsaw University of Technology, and doctoral students at the PW Doctoral school, who will act as a

substantive consultant to the team.

3. The SzIR-PN competition will be cancelled if fewer than six teams apply by the closing date for the application of teams (4 January 2024).
4. By entering the SzIR-PN competition, the participants declare that:
  - 1) They have read these Regulations and entered the SzIR-PN competition voluntarily.
  - 2) They agree to and accept the terms of the Regulations.
  - 3) They shall comply with the provisions of the Regulations.
  - 4) They have consented to the processing of personal data for the purpose of participating in the SzIR-PN competition.
5. By entering the SzIR-PN competition, the applicants shall commit themselves to transferring the proprietary copyrights of their entry.
6. The application, prepared in accordance with the template attached as Annex No. 2 to the Regulations, shall be submitted electronically via the online form available on the website by 4 January 2024.

### § 3.

1. The competition entries shall be evaluated by a four-member committee appointed by the Scientific Council of the Research Centre for the Priority Research Area Artificial Intelligence and Robotics, hereinafter referred to as “RN CB POB SzIR”.
2. The evaluators of competition entries must not be in any formal or factual relationship with the members of the applying team and its mentor that may give rise to justified doubts as to their impartiality. If the committee member is in such a relationship with the team or mentor, they shall be excluded from the evaluation of this competition entry.
3. The criteria for the evaluation of the competition entry shall include:
  - 1) the innovation and scientific value of the proposed solution and the effectiveness of the generalisation for test problems;
  - 2) the substantive quality of the prepared draft of the publication, including references to the literature, a description of the innovative elements of the proposed solution and its additional analysis, among other things;
  - 3) the effectiveness of the proposed model/product based on a test dataset consisting of a public part and a private (classified) part.
4. The evaluation of competition entries shall consist of two stages:
  - 1) The first stage consists of the evaluation of each product and proposed publications by the committee members. The most highly rated competition entries are forwarded to the second stage. Information on whether or not a competition entry is eligible for the second stage of evaluation shall be given to the teams immediately after the evaluation committee’s decision.
  - 2) The second stage consists of a seminar presentation of the competition entries qualified in the first stage. The committee shall prepare the final evaluation of the competition entries on this basis.
5. The result of the SzIR-PN competition shall be published on the website [www.badawcza.pw.edu.pl](http://www.badawcza.pw.edu.pl) by 20 June 2024.

### § 4.

The funds allocated for the SzIR-PN competition prizes amount to PLN 49,950:

- 1) for winning the first place – PLN 4,300 for each team member;
- 2) for winning the second place – PLN 3,850 for each team member;
- 3) for winning the third place – PLN 3,500 for each team member;
- 4) a prize of PLN 5,000 for the mentor of each awarded team.



## § 5.

1. In publications, teams shall use the affiliation with the Warsaw University of Technology, which means that all publications must contain the following clause:
  - 1) *The research was funded by POB Artificial Intelligence and Robotics of the Warsaw University of Technology within the Excellence Initiative: Research University (IDUB) programme.*
  - or
  - 2) *Badania były finansowane przez POB Sztuczna inteligencja i robotyka ze środków Politechniki Warszawskiej w ramach Programu Inicjatywa Doskonałości – Uczelnia Badawcza (IDUB).*
2. All matters unregulated herein shall be settled by the Vice-Rector for Development.

## § 6.

Under Article 13 of the Regulation (EU) 2016/679 of the European Parliament and of the European Council of 27 April 2016 on the protection of natural persons concerning the processing of personal data and the free movement of such data and repealing Directive 95/46/EC (General Data Protection Regulation, Journal of Laws EU L 119/1 of 4 May 2016), hereinafter referred to as “GDPR”, the Warsaw University of Technology announces that:

- 1) The Administrator of your personal data is the Warsaw University of Technology with its registered seat at pl. Politechniki 1, 00-661 Warsaw.
- 2) The Administrator has appointed the Inspector for Data Protection (IOD - Inspektor Ochrony Danych), who ensures that the data are processed lawfully, and who can be contacted via email: [iod@pw.edu.pl](mailto:iod@pw.edu.pl).
- 3) The Administrator shall process the personal data in the scope included in the application and intermediate and final reports on the project implementation.
- 4) Your personal data shall be processed by the Administrator to implement the 04/IDUB/2019/94 Agreement concluded on 30 December 2019 – your personal data shall be processed based on Article 6 section 1 point b) of GDPR.
- 5) The Warsaw University of Technology shall not transfer your data outside the European Economic Area.
- 6) You shall have the right to access your personal data, the right to request the correction or deletion of the data, the right to request a restriction to process your personal data, and object to processing your data. Since the data are not processed based on your consent, the right to data portability does not apply.
- 7) Your personal data shall not be disclosed to any other entities (administrators) except for the entities entitled, in compliance with generally applicable laws.
- 8) Entities (processing entities) commissioned by the Warsaw University of Technology to perform actions that may relate to personal data processing may have access to your personal data.
- 9) The Warsaw University of Technology shall not subject you to automated decision-making, including your profiling.
- 10) You shall provide your personal data voluntarily. Nevertheless, if you fail to do so, it will prevent you from obtaining funding for a research grant as part of CB POB competitions.
- 11) Your personal data shall be processed for the period compliant with the “A” archiving category in the documentation.
- 12) If you think your data protection rights as specified in GDPR have been violated, you have the right to lodge a complaint to a supervising body – the Polish Data Protection Commissioner.

## Task description

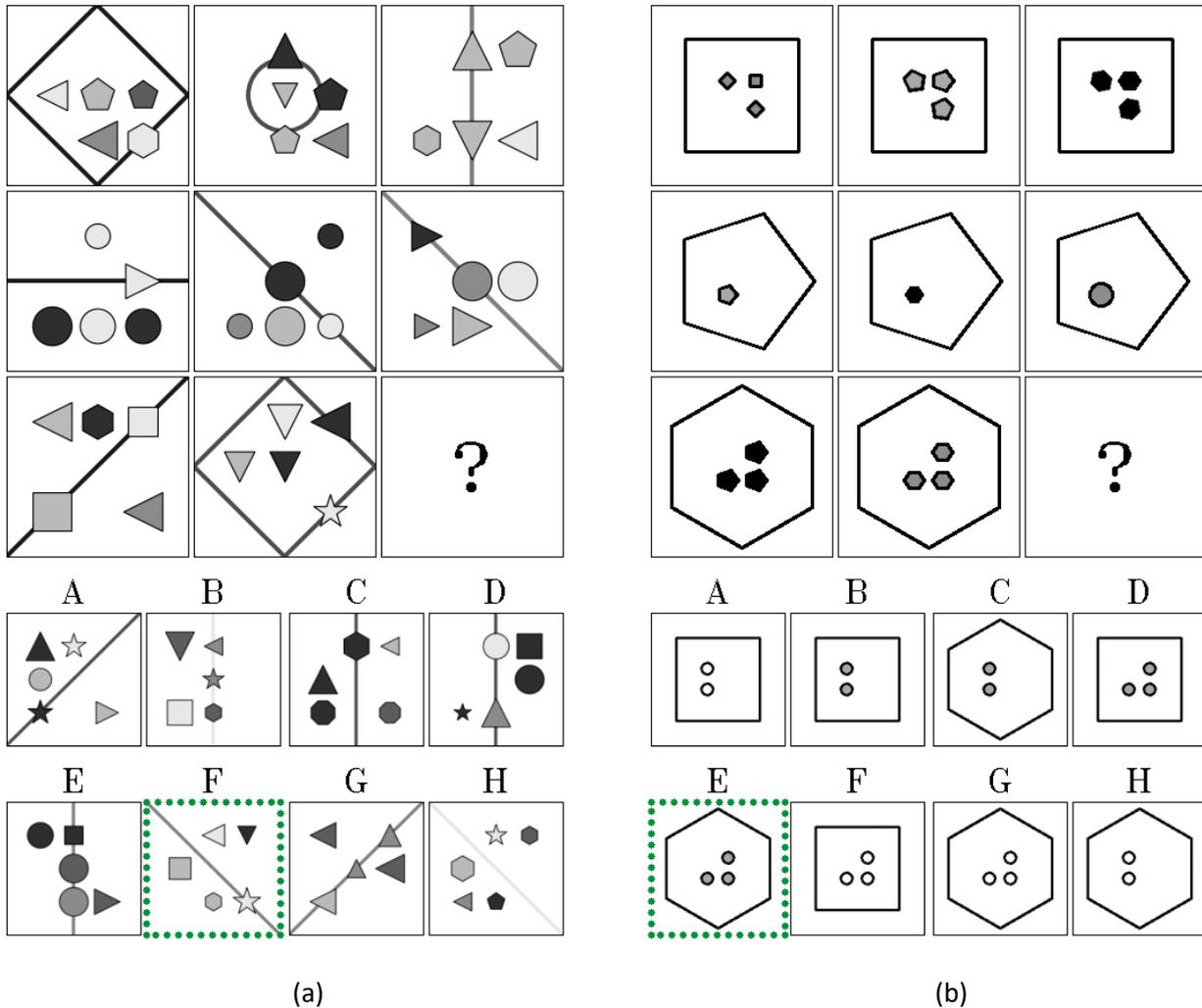
Raven's Progressive Matrices (RPM) are one of the most widely used tasks in intelligence tests (IQ), used to assess abstract reasoning, creation of analogies, and discovery of rules. A typical matrix consists of eight drawings, each of which depicts two-dimensional objects described by a pre-defined set of attributes (e.g. shape, size, colour). The drawings are laid out as a 3x3 grid with a missing right bottom panel. The task involves completing the matrix with a missing drawing by selecting it from eight available options. To accomplish the task, it is necessary to recognise the hidden rules determining the values of object attributes. Sample matrices are depicted in Figure 1. Currently, the creation of machine learning algorithms solving the above-mentioned Raven's matrices is one of the crucial challenges for artificial intelligence where computer vision and abstract reasoning meet.

In the scientific literature on artificial intelligence, several proposals of RPM datasets can be found, differing in the number of examples, sets of attributes, and sets of adopted rules. These datasets are used to train machine learning models, mainly RPM-solving deep neural networks. Procedurally Generated Matrices (PGMs) are one of the popular datasets, which offer some interesting generalisation challenges. For instance, one of them checks how a model trained on a defined set of rules manages to deal with test matrices that require the identification of other rules not occurring in the training set. For the time being, no model available in the literature has managed to solve all generalisation challenges applying to this set.

One of the reasons for the above situation is the exceptionally large amount of data available in the PGM dataset, which involves high computational requirements. Consequently, the majority of research on RPMs is conducted on the I-RAVEN [2] dataset (which is an improved version of the RAVEN [3] dataset), which is characterised by a lower amount of data and relatively simpler matrices. However, the I-RAVEN dataset is not adjusted to measure generalisations of devised methods on out-of-distribution test data.

The I-RAVEN dataset was modified for the competition to define several generalisation challenges along the lines of the PGM dataset. **The main aim of the competition is to devise an innovative method of machine learning responding to the prepared generalisation challenges. A detailed description of each challenge will be made available with datasets. Additionally, along with building innovative machine learning systems, the competition will aim to familiarise students with the methodology of conducting research projects.**

Solving Raven's matrices with machine learning involves the preparation of a classifier that will return an index of correct answers for sixteen drawings at the start (eight contextual drawings and eight answers). Examples of current systems for solving Raven's matrices are discussed in the review paper [4]. Due to the relatively small size of the I-RAVEN dataset, research can be conducted on computers with ordinary graphic cards (the so-called *consumer GPUs*) and does not require access to a computational cluster.



**Figure 1.** Sample Raven's matrices. (a) Matrix from the PGM dataset [1]. The solution is to notice that in each row the set of object shapes in the drawing in the third column is a set theory sum of object shapes in the first and second drawing. (b) Matrix from the I-RAVEN [2] dataset. The solution is to notice that in each row the external objects have the same shape, the number of internal objects is constant across the rows, and the colours of the internal objects in each row belong to the same three-element set.

## References

- [1] Barrett, David, et al. "Measuring abstract reasoning in neural networks." International conference on machine learning. PMLR, 2018.
- [2] Hu, Sheng, et al. "Stratified rule-aware network for abstract visual reasoning." Proceedings of the AAAI Conference on Artificial Intelligence. Vol. 35. No. 2. 2021.
- [3] Zhang, Chi, et al. "Raven: A dataset for relational and analogical visual reasoning." Proceedings of the IEEE/CVF conference on computer vision and pattern recognition. 2019.
- [4] Małkiński, Mikołaj, and Jacek Mańdziuk. "Deep Learning Methods for Abstract Visual Reasoning: A Survey on Raven's Progressive Matrices." arXiv preprint arXiv:2201.12382 (2022)



## **Application for the SzIR-PN competition**

### **DATA**

1. Data of the head of the team:  
*(name and surname, PW faculty, year and semester of studies, type of programme: first- or second-cycle degree, contact details: e-mail, phone number)*
2. Team members – a list of implementers' names:  
*(name and surname, PW faculty, year and semester of studies, type of programme: first- or second-cycle degree)*
3. Data of the mentor:  
*(name and surname, degree/title, PW faculty, institute/chair/division, (doctoral student) contact details: e-mail, phone number)*

**By submitting this application, I accept that if a prize is awarded, the names of the team members and their mentor, as well as the name of the product, will be made public in the information about the competition and its results.**