SPECIFICATION FOR COMPETITION OF ARTIFICIAL INTELLIGENCE IN HEALTH 2024

İÇİNDEKİLER

TABLES

1. DEFINITIONS

Advisory and Evaluation Board: TEKNOFEST Artificial Intelligence in Health Competition, consisting of experts in their fields who take part in issues such as report evaluation, specification revision processes, report template creation, answering technical questions, and creating a competitor information kit,

Bank Statement Form: A printed form in which the person on whose behalf the payment will be made declares the bank information and the necessary personal information (See. Annex-2),

Competition Process: The period between the date when the applications for the competition start to be received and the date when the final results are announced,

Competitors Officer: TUSEB personnel assigned to deal with the needs and demands of the competitors,

Higher Education Competition: Competitions in which students or graduates of higher education institutions will participate,

KYS: TEKNOFEST Institutional Management System,

Secondary Education Competition: A competition for high school students or those who have completed high school and are not enrolled in any other educational institution,

Nondisclosure Agreement: The "Corporate Confidentiality Undertaking" signed by the contestants in order to be able to use the anonymized information/document/data shared by the Republic of Turkey Ministry of Health within the scope of the Artificial Intelligence in Health Competition in order to train and/or test the models of the contestants,

Stakeholder: Republic of Türkiye Ministry of Health, Health Institutes of Turkey, T3 Foundation,

System: A layout that includes all kinds of hardware and software necessary for the competitors' solutions and proposals to be operational,

T3 Foundation: Türkiye Technology Team Foundation,

Team: The group consisting of 1 (one) or at most 5 (five) people,

Team Captain: Team member authorized to represent the team in team competitions,

Team Consultant: Being mandatory in secondary education competitions, optional in higher education competitions; maximum 1 (one) teacher/instructor/academic for each team,

Team Official: Team consultant in secondary education competitions, team captain and/or team consultant in higher education competitions,

TEKNOFEST: Aerospace and Technology Festival,

TEKNOFEST Competitions Committee: Committee formed by the relevant members responsible for stakeholder Institutions,

TUSEB: Health Institutes of Türkiye,

2. AIM

Today, artificial intelligence solutions are widely used in the field of information technologies and recently, the role of these technologies in the healthcare sector has gained importance. In this context, the "Artificial Intelligence in Health Competition", organized to find solutions to the challenges faced in health and to increase knowledge, will be organized with a hybrid content covering Computer Vision and Natural Language Processing at the 2024 TEKNOFEST event. The excitement continues at TEKNOFEST 2024, where it left off in 2023. The competition is titled "Analysis of Mammography Images with Computer Vision and Named Entity Recognition from Mammography Radiology Reports and BI-RADS Category Prediction" and will offer participants the opportunity to contribute to technological developments in this field. This 2024 TEKNOFEST competition aims to support the advancement of artificial intelligence applications in the healthcare sector. Participants in the competition will bring together their experience in information technologies and health sciences to develop projects for the health technologies of the future. The competition aims not only to showcase computerized image processing and natural language processing skills, but also to offer solutions that will lead innovations in the healthcare industry. The 2024 TEKNOFEST competition invites exciting projects that combine expertise in information technologies and health sciences, taking a holistic approach in both image processing and natural language processing.

3. CONDITIONS FOR PARTICIPATION

- High school students and graduates studying in Türkiye and abroad can apply for the Secondary Education Competition, while university students (including undergraduate, associate, graduate, doctorate and open education) and graduates can apply for the Higher Education Competition.
- Individuals can participate in the competitions or apply as a team.
- A team member cannot be a member of another team in the same competition.
- In the competition, teams can consist of one person or a maximum of 5 (five) people. (This number does not include the consultant.)
- Teams can be formed from a single school or a mixed team of one or more secondary/higher education students.
- Along with the Project Detail Report, approved student documents for students must be submitted to www.t3kys.com.
- Only in the Secondary Education competition, teams must have a consultant.
- It is not mandatory to have a consultant for applications to the Higher Education competition.
- The duty of the consultant is to assist students in planning their own education, to guide them in academic, social and cultural matters, to help prepare the appropriate environment for the development of the student's personality as a whole in terms of mental, social and emotional aspects, etc. duties and services. The role of the consultant in the team is to provide the academic support needed in the project and to guide the team members to find solutions to their problems. The project idea must be created by the team members and the consultants are only asked to provide guidance

at this stage. If it is determined that the project owner is a consultant, the application will be invalidated.

- The consultant should not be added as a team member.
- The person who will serve as a consultant must submit a scanned document with wet signature/electronic signature proving that he/she will fulfil his/her consultancy duties and that he/she is a teacher/trainer/academician or an engineer/specialist etc. who continues his/her career life in the relevant field and the assignment letter from the institution where he/she works to the TEKNOFEST Competitions Committee (www.t3kys.com) until the Project Detail Report submission date.
- Although the model, code and all kinds of reports produced at every stage of the competition are the result of the labour of the competitor / competitors in the team, they reflect the characteristics of the team members and the Consultant will not be accepted as the owner of the work.
- The consultant undertakes to support the team until the final stage and to be with the team during the final stage. It is mandatory for the teams to be in the field with their consultants in the projects that reach the final stage.
- In case of a consultant change, they must submit their request in writing to the relevant TEKNOFEST Competitions Committee within 7 working days. The change of consultant of the teams that do not make their requests as written in this article will not be accepted.
- The artificial intelligence methods used should be summarized in the **Project Presentation Report** and explained in detail in the **Project Detail Report**.
- Applications are made online via www.t3kys.com application system until 29.02.2024.
- Between the application dates, the Team Officer registers through the system, registers the team members correctly and completely in the system and sends invitations to the e-mails of the consultant and members (if any). The member to whom the invitation is sent logs into the Application system and accepts the invitation from the "My team information" section and the registration is completed. Otherwise, the registration is not considered complete.
- Competitors who have completed the team formation process must apply to the competition suitable for their project.
- All necessary processes within the scope of the competition (Application, Report Receipt, Report Results, Appeal Processes, Member addition/removal processes, etc.) are carried out through KYS. Teams are required to follow their processes through KYS.
- Member additions/removals must be made until the Project Detail Report submission date.
- During the competition process, the processes of applying, uploading reports, and filling out forms through the KYS are within the scope of the Team Official and the competition processes are managed through this Team Official.
- The transportation and accommodation support to be provided to the finalist teams is limited. The number of people to be supported is 3 people per team (including the advisor) and TEKNOFEST Competitions Committee reserves the right to make changes.
- TEKNOFEST Competitions Committee has the authority to limit the number of members in the festival area. In case of a limitation, the committee will be informed by the committee.

- The same team members can apply to other competitions organized within the scope of TEKNOFEST with different projects.
- Competitors will only be able to access the data to be provided by stakeholders in the competition and participate in the competition if they submit a signed "Confidentiality Agreement".
- The competitor will be able to participate in the competition by reading and approving all the explanations and conditions of participation in this specification before applying. If the competitor is under the age of 18 (eighteen), a document showing that these specifications have been approved by his/her parent/guardian must be submitted.

Applicants are deemed to have accepted all of the conditions in this specification.

4. DETAILS OF ARTIFICIAL INTELLIGENCE IN HEALTH COMPETITIONS

Topic: *Computer Vision Analysis of Mammography Images and Named Entity Recognition from Mammography Radiology Reports and BI-RADS Category Prediction*

Within this organization, two competitions will be organized: Secondary Education Competition and Higher Education Competition. Secondary Education and Higher Education Competitions will be evaluated internally and the results will be announced separately for both competitions.

4.1 Details Of Aim And Problem

Artificial intelligence is making an important contribution to mammography evaluations. Advanced deep learning algorithms can analyse mammography images in detail to detect potential abnormalities more precisely and support radiologists in making more accurate diagnoses. Thanks to artificial intelligence, the ability to learn from large data sets makes it possible to identify breast lesions at earlier stages and thus improve treatment processes. Furthermore, AI systems, with their ability to quickly process large amounts of data, reduce the workload of radiologists and enable a more efficient diagnostic process. In this way, the use of AI in mammography evaluations represents an important step towards developing a more reliable and accessible medical imaging practice in the healthcare sector.

In the 2023 TEKNOFEST Competition, for the category "BI-RADS Category and Breast Composition Estimation in Computer Vision Screening Mammograms", the data set provided by the Republic of Türkiye Ministry of Health - General Directorate of Health Information Systems to Health Institutes of Türkiye (TÜSEB) was used. From this dataset, competitors were asked to produce outputs of breast composition information, BI-RADS estimates (BI-RADS0, BI-RADS1-2, BI-RADS4-5) and breast quadrant information related to the BI-RADS estimate. Within the scope of the competition, the existence of the BI-RADS0 category created uncertainty for the competitors and constituted the most challenging category. In this context, the participants were expected to develop innovative artificial intelligence solutions by overcoming the challenges in this critical category.

This year's competition (TEKNOFEST 2024) aims to build on last year's competition (TEKNOFEST 2023) by adding a number of new capabilities and experiencing new areas. The competition titled *"Analysis of Mammography Images with Computer Vision and Named Entity Recognition from Mammography Radiology Reports and BI-RADS Category Prediction"* aims to present artificial intelligence solutions consisting of two stages.

4.2 Stages Of Competition

First Stage: *Analysis of Mammography Images with Computer Vision*

Aim in the first stage;

Mammography is one of the radiologic imaging modalities commonly used for breast cancer screening and diagnosis. It is used to detect abnormal changes and lesions in breast tissue. Generally, images are obtained in two projections (Mediolateraloblique-MLO and craniocaudal-CC). However, additional projections can be obtained after the initial evaluation. Important findings on mammography include mass, calcification, structural distortion, asymmetry and associated findings. A mass is a space-occupying lesion seen in two different projections. It may show different shapes, edges and density patterns. Calcifications are small, white dots that appear on these images. They may show different shapes and distribution patterns. They may be of typical benign or suspicious morphology. Each case will include two projection images (MLO and CC) in the training and test data to be shared for the competition. As shown in Figure 1, mass and calcification areas (only those with suspicious morphology) will be tagged with a bounding box in the mammogram images of the case and shared with the competitors. In addition, the highest risk BI-RADS category information for the image of the case will be provided. As shown in Figure 1, there is a mass lesion in the red box and an area of amorphous calcification (calcification type with suspicious morphology) in the yellow box. The mammography report of the patient with these two significant findings was reported as "BI-RADS 5" category.

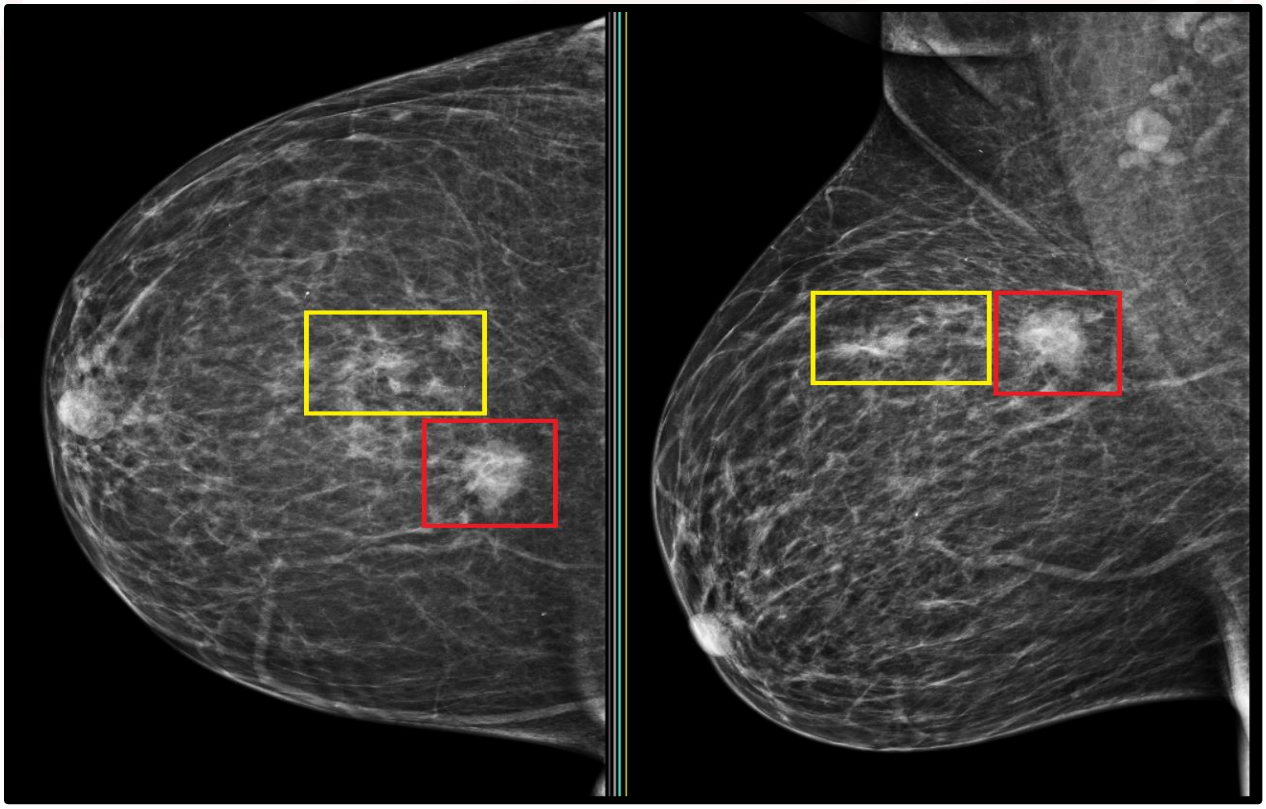

Figure 1 Example of tagging a mammography image

Computer vision is expected to produce 3 outputs: mass, calcification detection and BI-RADS (BI-RADS 1,2,4,5) category prediction. Bounding box may be absent in one case (BI-RADS 1 case) or may be more than one as a result of significant findings (mass and calcifications with suspicious morphology). In addition, in the context of important findings, there may be independent bounding boxes in the image as well as intersecting, intertwined bounding boxes (such as calcification with suspicious morphology within the mass).

Second Stage: *Mammography Radiology Reports Named Entity Recognition and BI-RADS Category Prediction*

Aim in the second stage;

- Development of Named Entity Recognition (NER) models in mammography radiology reports.
- Establishing usable and effective NER models in the health sector.
- Finding solutions to accurately extract important information from textual reports.

What is NER?

Named Entity Recognition (NER) is the process of identifying entities in text that belong to specific categories. These entities usually belong to specific categories such as person names, place names, dates, numbers or special terms. As a subfield of Natural Language Processing (NLP), NER can be treated as a sequence classification problem.

The Use Of NER In Radiology Reports

Mammography radiology reports contain critical information about patients' health status. The application of NER models to these reports enables healthcare professionals to obtain information quickly and accurately by highlighting important asset names in different colours or presenting them in different formats within the text. This competition encourages innovative NER solutions that successfully extract various asset types from radiology reports.

BI-RADS and NLP

BI-RADS stands for "Breast Imaging Reporting and Data System" and is known as breast imaging reporting and data system. This system aims to standardize the findings of breast imaging modalities such as mammography. BI-RADS is a grading system for the evaluation of breast tissue and possible lesions. This system allows radiologists to classify their findings into specific categories, facilitating clinical decision-making. Mammography reports from breast cancer screening processes often contain detailed language that requires specialized expertise. With the ability to understand, parse and classify this text data, NLP can help radiologists and healthcare professionals quickly and accurately identify BI-RADS categories. By processing text data, NLP algorithms can extract important information such as specific anatomy tags, observations, suspicious conditions and opinions. This not only allows patients to be directed to the correct diagnosis and treatment more quickly, but also enables healthcare professionals to utilize the information more effectively in large data sets.

As shown in Figure 2, a dataset containing a specified number of tagged and untagged radiology reports written in free text format will be shared for training purposes in the pre-competition process. The tagged texts will contain five different types of tag information. These are: the anatomy tag (ANATOMY, ANAT), the tag indicating that the observation is present (OBSERVATION-PRESENT, OBS-P), the tag indicating that the observation is not present (OBSERVATION-ABSENT, OBS-A), the tag indicating that the observation is doubtful or uncertain (OBSERVATION-UNCERTAIN, OBS-U), and finally the tag expressing opinion (IMPRESSION, IMP). These various labels represent various aspects of the mammography reports in the dataset.

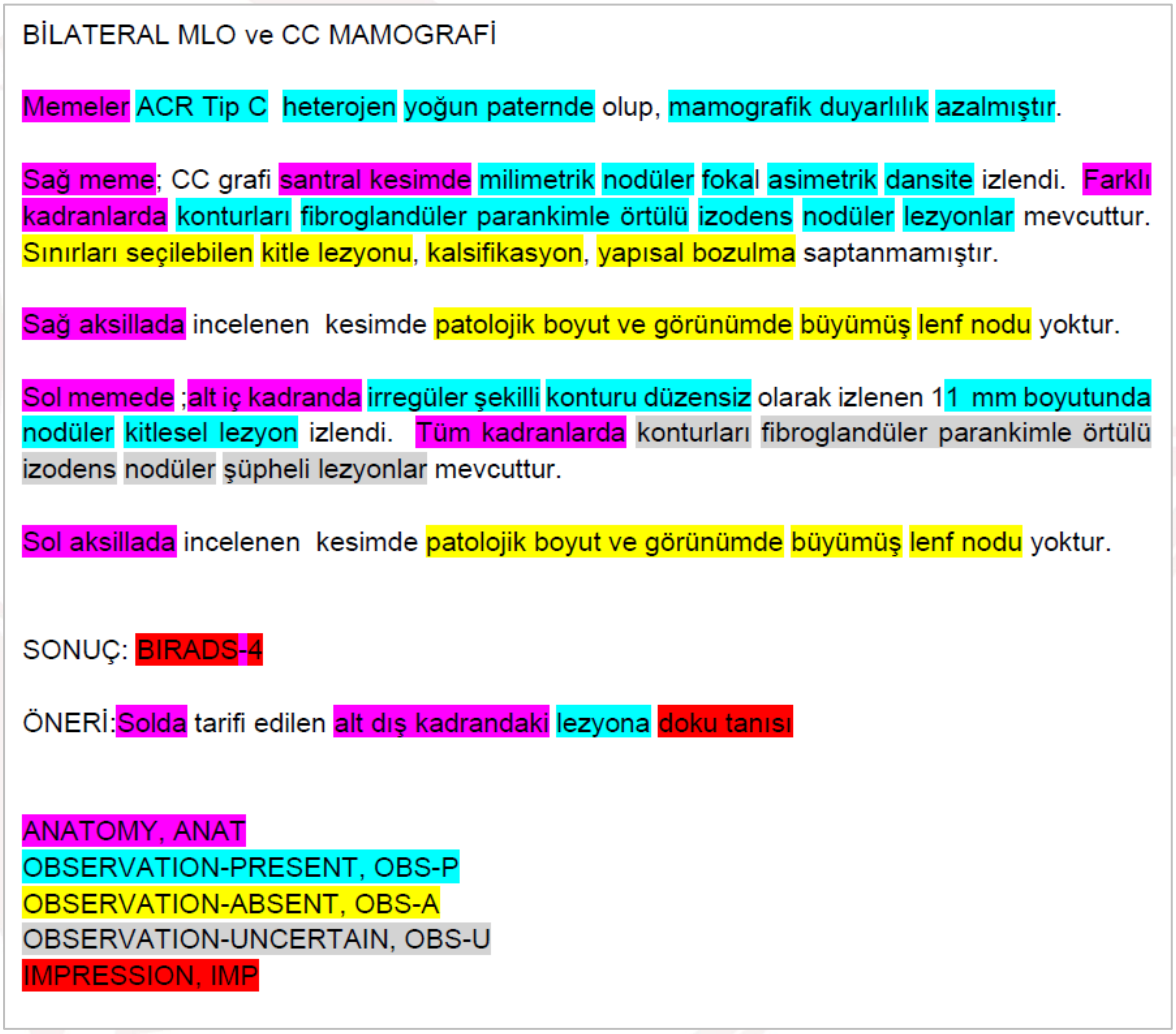

Figure 2 Sample Mammography Report and tags

4.3 Final Evaluation

During the competition, competitors will be provided with a set number of specific test cases (images and reports) to test the success of the models. In the first phase, competitors are expected to perform mass, calcification detection and BI-RADS category prediction for each shared image. In the second phase, asset level and BI-RADS category prediction information will be requested in mammography reports.

In the evaluation of the results of the competition:

- The final score calculation of the competition will be based 70% on the first stage output and 30% on the second stage output.
- In the first stage, the score to be determined by weighting the success scores obtained from 3 different results (mass and calcification detection, BI-RADS category prediction) for each case will constitute 70% of the total score of the competition. These weights will be calculated as 0.30 for mass detection, 0.35 for calcification (showing suspicious morphology) detection and 0.35 for BI-RADS category detection.
- In the BI-RADS classification problem, the macro F1-score, which is calculated from the precision and recall per class, will be used as the basis for evaluation.
- The "Intersection over Union" (IoU) metric will be used for mass and calcification detection. IoU is a ratio of the total area between the predicted region and the actual region. For object detection score calculation, mAP@IoU=(0.50: 0.05: 0.95) (primary challenge metric, known as COCO metric)
- In the second stage, the VIW models will be evaluated as a set of classification problems with asset-level precision, sensitivity and F1-score measures. These class-based scores can be converted into representative single scores for the model in the form of macro-averages and micro-averages. BI-RADS category prediction models can be treated as a text classification problem. In this case, the model will be applied to a separate test set and evaluated on accuracy, precision, sensitivity and F1-score. These class-based scores can be converted into representative single scores for the model in the form of macro-averages and micro-averages.
- The final scoring of the competition will be based on 70% first stage scores and 30% second stage scores. In this way, the total points of the teams will be determined, and their success ranking will be revealed. The top 3 teams according to the order of success will win the specified prize amounts.

5. COMPETITION SCHEDULE

Table 1. Competition Schedule

Date	Explanation
29.02.2024	Competition Application Deadline
23.03.2024	Question & Answer Meeting with Teams – 1
01.04.2024	Submission Deadline of Project Presentation Report
29.04.2024	Announcement of the Qualifying Teams according to the Results of the Project Presentation Report
06.05.2024	Sharing Mammography Images and Mammography Reports
15.05.2024	Question & Answer Meeting with Teams – 2
24.06.2024	Submission Deadline of Project Detail Report
10.07.2024	Announcement of Project Detail Report Results and Finalist Teams
August-September 2024	Competition Date

Data to be shared: For the competitors, the image and report to be shared with all teams that have passed the pre-qualification is the training data. Enough data will be shared for training.

5.1 Question & Answer Meeting with Teams – 1

A question-and-answer meeting will be held with the teams after the competition applications are completed. Information about the meeting will be announced later.

5.2 Evaluation of Competition

The Project Presentation Report is pre-selected by the Advisory and Evaluation Board. Reports submitted out of scope are not evaluated. The Team that will be eliminated in this context has no right of appeal. The Project Detail Report submitted by those who pass this stage is evaluated by the Advisory and Evaluation Board. Those who pass the evaluation according to the Project Detail Report are entitled to participate in the final. Finalists are evaluated by the Advisory and Evaluation Board in accordance with the Final Evaluation specified and the winners are announced.

5.3 Submission and Evaluation of Project Presentation Report

Teams must upload the Project Presentation Report to the KYS system by the date specified on the TEKNOFEST website and in accordance with the report format to be specified. Detailed information about the submission of Project Presentation Reports will be shared with the teams that have completed their application after the end of the competition application date. These reports will be reviewed by the Advisory and Evaluation Board and the teams that are eligible to continue the competition will be announced. Reports submitted outside the scope will not be evaluated. After the Project

Presentation Reports are evaluated and scored by the Advisory and Evaluation Board, the teams that receive the threshold score and above determined by the TEKNOFEST Competitions Committee will be able to continue to the next stage. Teams that do not submit a Project Presentation Report or submit a report outside the scope of the subject, teams whose submitted report is below the threshold score determined by the TEKNOFEST Competitions Committee will not be able to participate in the next stage. The project presentation report template will be available on the website.

5.4 Data Set to be Shared with Competitors

Upon completion of the applications, a certain number of tagged mammography images of the sample cases will be provided in DICOM and PNG formats, and mammography radiology reports will be provided in TXT (untagged) and JSON (tagged) formats. Teams can train or test their systems on this data. The Confidentiality Agreement required to access the data will first be approved by the Team Official through the system and then will be collected from the relevant Teams on the day of the Competition Final with wet signatures by all team members. The Team that fails to submit the wet signed Confidentiality Agreement will be disqualified from participating in the Competition Final. Detailed information on the subject will also be shared during the "Question and Answer Meetings".

5.5 Question & Answer Meeting with Teams – 2

A question-and-answer meeting will be held with the competitors who have passed the project presentation stage in order to answer questions about the competition. Competitors will be informed about any change in the meeting date and the meeting environment.

5.6 Submission and Evaluation of Project Detail Report

The Project Detail Report (PDR) template will be prepared specifically for the competition and presented on the TEKNOFEST website under the Artificial Intelligence in Health Competition. Teams that have passed to the Project Detail Report (PDR) stage must upload their Project Detail Reports to the KYS system by the date specified on the TEKNOFEST website and in accordance with the report template provided. After the Project Detail Reports are evaluated and scored by the Advisory and Evaluation Board, the teams that receive the threshold score and above determined by the TEKNOFEST Competitions Committee will be able to continue to the final stage. Teams that qualify for the final will be announced on the date specified in the Competition Schedule.

5.7 Competition Final

The finalists' algorithm/poster/application presentations are personally evaluated by the Advisory and Evaluation Board in the event area. The Advisory and Evaluation Board signs the result with a report in the competition area. Each Team arriving at the final area must fill in the Bank Statement Form for all members (including consultants), who are present and absent at the area, and submit it to the TÜSEB Competitors Officer before leaving the competition area. **The competition jury has the authority to ask the finalist teams to re-run their codes and find the results they declared.**

6. AWARDS

First Prize in Secondary Education Competition: 100.000 TL, Second Prize: 80.000 TL, Third Prize: 60.000 TL. First Prize in Higher Education Competition: 150.000 TL, Second Prize: 120.000 TL, Third Prize: 100.000 TL. *

Table 2: Awards

Ranks	Secondary Education Competition	Consultant
First	100.000,00 ₺	6.000,00 ₺
Second	80.000,00 ₺	6.000,00 ₺
Third	60.000,00 ₺	6.000,00 ₺
Ranks	Higher Education Competition	Consultant
First	150.000,00 ₺	6.000,00 ₺
Second	120.000,00 ₺	6.000,00 ₺
Third	100.000,00 ₺	6.000,00 ₺

(The payments to be made include taxes, fees, etc., and the value of the prize to be obtained by the contestant will be the remainder after the legal deductions in question are deducted).

6.1 Best Presentation Awards

The finalist teams will prepare their presentations in the presentation format determined by TEKNOFEST. These presentations will be evaluated by the members of the Advisory and Evaluation Board in terms of presentation techniques and will be awarded with a plaque under the name of "Best Presentation Award" on behalf of the team. The presentation will be evaluated independently of whether the Team is ranked or not. The specified award is for prestige purposes and has no financial equivalent.

6.2 Considerations related to Awards

- Awards are available for teams that meet the success criteria.
- Prizes will be awarded to teams and divided equally between team members.
- For foreign nationals who do not have an account in a bank operating in Türkiye, team members are required to designate a person resident in Türkiye as a trustee. The relevant document is given in Annex-1.
- Payment will be made to the competitors'
  o bank accounts, if any, or
  o representative, parent, guardian, or custodian as appropriate, with documentation according to the central government spending documents regulation for competitors who are not legally of age. Therefore, the Bank Statement Form in Annex-2 should be filled accordingly.
- Competitors must submit all documents related to the payment to TÜSEB with wet signature in order for the payment to be made.
- In the secondary education competition, regardless of the number of advisors (including persons performing the same task) for the team that achieved a ranking, a maximum payment of 6000.00 TL per competitor or team will be made.
- The provisions of the Regulation on Awards of Health Institutes of Türkiye

published in the Official Gazette dated 25.09.2021 and numbered 31609 and the provisions of the Regulation on Central Government Expenditure Documents published in the Official Gazette dated 31.12.2005 and numbered 26040 will be taken as basis in other matters regarding the award.

7. GENERAL AND ETHICAL RULES

Click here to access the General and Ethical Rules booklet which is valid within the scope of the competition.

6.3 State of Responsibility

- TEKNOFEST and Stakeholder Institutions are in no way responsible for any product delivered by the competitors or for any injury or damage caused by the competitor. TEKNOFEST, Stakeholder Institutions and organization officials are not responsible for any damages caused by competitors to third parties. TEKNOFEST and Stakeholder Institutions are not responsible for ensuring that teams prepare and implement their own systems within the framework of the laws of the Republic of Türkiye.

6.4 Use / Processing of Personal Data

The personal data of the applicants (TR ID Number, e-mail, phone number, IBAN, Identity Register Copy) may be processed and transferred by TÜSEB in relation to the works and operations carried out within the scope of award payment and promotional activities. The mentioned personal data are processed in accordance with the provisions of "It is mandatory for the data controller to fulfil its legal obligation" specified in subparagraph (ç) of the second paragraph of Article 5 of the Personal Data Protection Law No. 6698 and "Data processing is mandatory for the legitimate interests of the data controller, provided that it does not harm the fundamental rights and freedoms of the data subject" specified in subparagraph (f) of the second paragraph of Article 5. It is accepted that the personal data sent by you to TÜSEB are obtained in accordance with the legislation and that the necessary technical and administrative measures regarding this personal data are taken by you. Personal data obtained in this way may be transferred to authorized public institutions and organizations, natural persons and private legal entities in accordance with the purpose of the relationship between the parties and Article 8 of Law No. 6698. As the data controller, you can exercise your rights regarding your personal data submitted to TUSEB in accordance with the provisions of Article 11 of Law No. 6698.

TEKNOFEST and Stakeholder Institutions reserve the right to make any changes in this specification and related documents (report templates, forms, etc.).

7th YEAR

#MİLLİ TEKNOLOJİ HAMLESİ