Checklist for Adult Sponsor (1)

This completed form is required for ALL projects.

To be completed by the Adult Sponsor in collaboration with the student researcher(s):

Student's Name(s): Aditya Kendre

Project Title: Employing Adversarial Machine Learning and Computer Audition for Smartphone-Based Real-Time Arrhythmia Classification in Heart Sounds

1. ☑ I have reviewed the ISEF Rules and Guidelines.

2. ☑ I have reviewed the student's completed Student Checklist (1A) and Research Plan/Project Summary.

3. ☑ I have worked with the student and we have discussed the possible risks involved in the project.

4. ☐ The project involves one or more of the following and requires prior approval by an SRC, IRB, IACUC or IBC:
   - ☐ Humans
   - ☐ Vertebrate Animals
   - ☐ Potentially Hazardous Biological Agents
   - ☐ Microorganisms ☐ rDNA ☐ Tissues

5. ☑ Items to be completed for **ALL PROJECTS**
   - ☑ Adult Sponsor Checklist (1)
   - ☑ Student Checklist (1A)
   - ☑ Research Plan/Project Summary
   - ☑ Approval Form (1B)
   - ☐ Regulated Research Institutional/Industrial Setting Form (1C) (when applicable; after completed experiment)
   - ☑ Continuation/Research Progression Form (7) (when applicable)

Additional forms required if the project includes the use of one or more of the following (check all that apply):

☐ **Humans,** including student designed inventions/prototypes. (Requires prior approval by an Institutional Review Board (IRB); see full text of the rules.)
- ☐ Human Participants Form (4) or appropriate Institutional IRB documentation
- ☐ Sample of Informed Consent Form (when applicable and/or required by the IRB)
- ☐ Qualified Scientist Form (2) (when applicable and/or required by the IRB)

☐ **Vertebrate Animals** (Requires prior approval, see full text of the rules.)
- ☐ Vertebrate Animal Form (5A) - for projects conducted in a school/home/field research site (SRC prior approval required.)
- ☐ Vertebrate Animal Form (5B) - for projects conducted at a Regulated Research Institution. (Institutional Animal Care and Use Committee (IACUC) approval required prior experimentation.)
- ☐ Qualified Scientist Form (2) (Required for all vertebrate animal projects at a regulated research site or when applicable)

☐ **Potentially Hazardous Biological Agents** (Requires prior approval by SRC, IACUC or IBC, see full text of the rules.)
- ☐ Potentially Hazardous Biological Agents Risk Assessment Form (6A)
- ☐ Human and Vertebrate Animal Tissue Form (6B) - to be completed in addition to Form 6A when project involves the use of fresh or frozen tissue, primary cell cultures, blood, blood products and body fluids.
- ☐ Qualified Scientist Form (2) (when applicable)
- ☐ The following are exempt from prior review but require a Risk Assessment Form 3: projects involving protists, archae and similar microorganisms, for projects using manure for composting, fuel production or other non-culturing experiments, projects using color change coliform water test kits, microbial fuel cells, and projects involving decomposing vertebrate organisms.

☐ **Hazardous Chemicals, Activities and Devices** (No SRC prior approval required, see full text of the rules.)
- ☐ Risk Assessment Form (3)
- ☐ Qualified Scientist Form (2) (required for projects involving DEA-controlled substances or when applicable)

☐ **Other**
- ☐ Risk Assessment Form (3)

Mike Floreck
Adult Sponsor's Printed Name

Signature

Date of Review (mm/dd/yy)

(717) 506-3413
Phone

mfloreck@cvschools.org
Email

Student Checklist (1A)

This form is required for ALL projects.

1. a. Student/Team Leader: Aditya Kendre Grade: 12

   Email: kendreaditya@gmail.com Phone: (717) 622-1281

   b. Team Member: _____ c. Team Member: _____

2. Title of Project:

   Employing Adversarial Machine Learning and Computer Audition for Smartphone-Based Real-Time Arrhythmia Classification in Heart Sounds

3. School: Cumberland Valley High School School Phone: (717) 506-3413

   School Address: 6746 Carlisle Pike
   Mechanicsburg, PA 17050

4. Adult Sponsor: Mike Floreck Phone/Email: mfloreck@cvschools.org

5. Does this project need SRC/IRB/IACUC or other pre-approval? ☐ Yes ☒ No Tentative start date: _____

6. Is this a continuation/progression from a previous year? ☑ Yes ☐ No
   If Yes:
   a. Attach the previous year's ☑ Abstract **and** ☑ Research Plan/Project Summary
   b. Explain how this project is new and different from previous years on
   ☑ ☐ Continuation/Research Progression Form (7)

7. This year's laboratory experiment/data collection:

   10/30/20 (Actual Start Date: (mm/dd/yy))

   4/19/21 (End Date: (mm/dd/yy))

8. Where will you conduct your experimentation? (check all that apply)

   ☒ Research Institution ☒ School ☒ Field ☒ Home ☐ Other: _____

9. List name and address of all non-home and non-school work site(s):

   Name: _____ _____

   Address: _____ _____

   _____ _____

   Phone/ email _____ _____

10. **Complete a Research Plan/Project Summary following the Research Plan/Project Summary instructions and attach to this form.**

11. **An abstract is required for all projects after experimentation.**

Approval Form (1B)

A completed form is required for each student, including all team members.

1. To Be Completed by Student and Parent

a. Student Acknowledgment:

- I understand the risks and possible dangers to me of the proposed research plan.
- I have read the ISEF Rules and Guidelines and will adhere to all International Rules when conducting this research.
- I have read and will abide by the following Ethics statement

Student researchers are expected to maintain the highest standards of honesty and integrity. Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include but are not limited to plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and ISEF.

Aditya Kendre		3/14/21
Student's Printed Name	Signature	Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

b. Parent/Guardian Approval: I have read and understand the risks and possible dangers involved in the **Research Plan/Project Summary**. I consent to my child participating in this research.

Nivrutti Kendre		3/14/21
Parent/Guardian's Printed Name	Signature	Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

2. To be completed by the local or affiliated Fair SRC

(Required for projects requiring prior SRC/IRB APPROVAL. Sign 2a or 2b as appropriate.)

a. Required for projects that need prior SRC/IRB approval BEFORE experimentation (humans, vertebrates or potentially hazardous biological agents).

The SRC/IRB has carefully studied this project's **Research Plan/Project Summary** and all the required forms are included. My signature indicates approval of the **Research Plan/Project Summary** before the student begins experimentation.

Mike Floreck

SRC/IRB Chair's Printed Name

Signature

Date of Approval (mm/dd/yy) (Must be prior to experimentation.)

OR

b. Required for research conducted at all Regulated Research Institutions with no prior fair SRC/IRB approval.

This project was conducted at a regulated research institution (**not home or high school, etc.**), was reviewed and approved by the proper institutional board before experimentation and complies with the ISEF Rules. **Attach (1C) and any required institutional approvals (e.g. IACUC, IRB).**

SRC Chair's Printed Name

Signature

Date of Signature (mm/dd/yy) (May be after experimentation)

3. Final ISEF Affiliated Fair SRC Approval (Required for ALL Projects)

SRC Approval After Experimentation and Before Competition at Regional/State/National Fair

I certify that this project adheres to the approved **Research Plan/Project Summary** and complies with all ISEF Rules.

Regional SRC Chair's Printed Name	Signature	Date of Approval (mm/dd/yy)
State/National SRC Chair's Printed Name *(where applicable)*	Signature	Date of Approval (mm/dd/yy)

Qualified Scientist Form (2)

May be required for research involving human participants, vertebrate animals, potentially hazardous biological agents, and hazardous substances and devices. Must be completed and signed before the start of student experimentation.

Student's Name(s): Aditya Kendre

Title of Project: Employing Adversarial Machine Learning and Computer Audition for Smartphone-Based Real-Time Arrhythmia Classification in Heart Sounds

To be completed by the Qualified Scientist:

Scientist Name: Lifang He

Educational Background: Machine Learning/Deep Learning/Biomedical Informatics

Degree(s): B.S., Computational Mathematics; Ph.D., Computer Science

Experience/Training as relates to the student's area of research: Biomedical Engineering in Machine Learning

Assistant Professor
Position:

Lehigh University
Institution:

BC 327, 113 Research Drive, Bethlehem, PA 18015
Address:

lih319@lehigh.edu
Email/Phone:

1. Have you reviewed the ISEF rules relevant to this project? ☑ Yes ☐ No
2. Will any of the following be used?
   a. Human participants ☐ Yes ☑ No
   b. Vertebrate animals ☐ Yes ☑ No
   c. Potentially hazardous biological agents (microorganisms, rDNA and tissues, including blood and blood products) ☐ Yes ☑ No
   d. Hazardous substances and devices ☐ Yes ☑ No
3. Will this study be a sub-set of a larger study? ☐ Yes ☑ No
4. Will you directly supervise the student? ☑ Yes ☐ No
   a. If no, who will directly supervise and serve as the Designated Supervisor?
   b. Experience/Training of the Designated Supervisor:

Assistant Professor at Lehigh University

To be completed by the Qualified Scientist:

I certify that I have reviewed and approved the Research Plan/Project Summary prior to the start of the experimentation. If the student or Designated Supervisor is not trained in the necessary procedures, I will ensure her/his training. I will provide advice and supervision during the research. I have a working knowledge of the techniques to be used by the student in the Research Plan/Project Summary. I understand that a Designated Supervisor is required when the student is not conducting experimentation under my direct supervision.

Lifang He
Qualified Scientist's Printed Name

Lifang He
Signature

04/14/21
Date of Approval (mm/dd/yy)

To be completed by the Designated Supervisor when the Qualified Scientist cannot directly supervise.

I certify that I have reviewed the Research Plan/Project Summary and have been trained in the techniques to be used by this student, and I will provide direct supervision.

Mike Floreck
Designated Supervisor's Printed Name

Signature

04/14/21
Date of Approval (mm/dd/yy)

(717) 506-3413
Phone

mfloreck@cvschools.org
Email

Risk Assessment Form (3)

Must be completed before experimentation.

Student's Name(s) Aditya Kendre

Title of Project Employing Adversarial Machine Learning and Computer Audition for Smartphone-Based Real-Time Arrhythmia Classification in Heart Sounds

To be completed by the Student Researcher(s) in collaboration with Designated Supervisor/Qualified Scientist:
(All questions must be answered; additional page(s) may be attached.)

1. List all hazardous chemicals, activities, or devices that will be used; identify microorganisms exempt from pre-approval (see Potentially Hazardous Biological Agent rules).
   Mobile devices such as phones and laptops.

2. Identify and assess the risks involved in this project.
   N/A

3. Describe the safety precautions and procedures that will be used to reduce the risks.
   N/A

4. Describe the disposal procedures that will be used (when applicable).
   N/A

5. List the source(s) of safety information.
   Mushroor, S., Haque, S., & Amir, R. A. (2019). The impact of smart phones and mobile devices on human health and life. International Journal Of Community Medicine And Public Health, 7(1), 9. https://doi.org/10.18203/2394-6040.ijcmph20195825

To be completed and signed by the Designated Supervisor (or Qualified Scientist, when applicable):
I agree with the risk assessment and safety precautions and procedures described above. I certify that I have reviewed the Research Plan/Project Summary and will provide direct supervision.

Mike Floreck

Designated Supervisor's Printed Name | Signature | Date of Review (mm/dd/yy)

Admin

Position & Institution

(717) 506-3413

Phone or email contact information

Experience/Training as relates to the student's area of research

Continuation/Research Progression Projects Form (7)

Required for projects that are a continuation/progression in the same field of study as a previous project.
This form must be accompanied by the previous year's abstract and Research Plan/Project Summary.

Student's Name(s) Aditya Kendre

To be completed by Student Researcher: List all components of the current project that make it new and different from previous research. The information must be on the form; use an additional form for previous year and earlier projects.

Components	Current Research Project	Previous Research Project: Year: 19-20
1. Title	Employing Adversarial Machine Learning and Computer Audition for Smartphone-Based Real-Time Arrhythmia Classification in Heart Sounds	ECG-Based Abnormal Heartbeat Classification: A Deep Learning Approach for Arrhythmia Detection
2. Change in goal/ purpose/objective	To create a lightweight, precise, and accurate model for predicting heart arrhythmias in Phonocardiograms using a Generative Adversarial Network capable of accurate diagnosis.	To create a model capable of surpassing the accuracy of Cardiologists in identifying heart arrhythmias in Electrocardiograms.
3. Changes in methodology	A Generative Adversarial Networks comprises of two models: a generator model and a classifier model (which contains a Convolutional Neural Network). The generator creates artificial PCG data to deceive the classifier into predicting the data is a real PCG signal while simultaneously being fed true PCG data from a dataset.	A Convolutional Neural Network extracts latent features from an electrocardiogram database following a fully-connected Linear layer that predicts whether an arrhythmia is present within the electrocardiogram, based upon the features extracted by the CNN.
4. Variable studied	Manipulated variables include: Learning Rate, Batch size, Number of Epochs, Hidden Layers, Hidden Units, Activations Functions, and level of Data Augmentation. Responding variables include: Loss, Accuracy, Recall, Precision, F-Beta Score, F1 Score, and ROC and AUC.	Manipulated variables include: Number of layers, Hidden Units, and the level of Data Augmentation. Responding variables include: Loss and Accuracy.
5. Additional changes	Conversion between ECG and PCG signals using an transGANs.	ECG signal with a one-dimensional CNN.

Attached are:

☑ Abstract and Research Plan/Project Summary, Year 19-20

I hereby certify that the above information is correct and that the current year Abstract & Certification and project display board properly reflect work done only in the current year.

Aditya Kendre		3/14/21
Student's Printed Name(s)	Signature	Date of Signature (mm/dd/yy)