Colorado Science and Engineering Fair

2025 Team Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: Revolutionizing CryoEt: Novel Simulation Techniques for ML-Based Tomograph Labeling

Team Leader's Name: Tanush Shekhar

Team Member 1: Jack Cerullo Team Member 2:

School and City: Peak to Peak Charter School, Lafayette, CO

Sponsor's Name: Bayley Zubler

Category: Mathematics & Computer Sciences Division: Senior (grades 9 - 12)

Abstract (250 words or less):

Cryo-electron tomography (CryoET) is a recent innovation for gathering detailed, microscopic biological images called tomographs. CryoET images are high-resolution and enable more accurate analysis of protein structures. These images are used to understand how different biological systems operate and were used in the fight against COVID-19 [1]. The end goal of these CryoET experiments is often to digitize and label a section of a cell for various uses. While this data shows a lot of promise, there is a lack of datasets for most biological problems, and scientific experts often have to hand-label different proteins, membranes, organelles, and other molecules within a tomograph. Streamlining this process is crucial to new innovations through CryoET. This leads many to believe [2] that machine learning, specifically deep learning through Convolutional Neural Networks (CNNs), shows a lot of promise in labeling these datasets; however, these neural networks are extremely difficult to train due to the scarcity of data. Generative Adversarial Networks (GANs) are a type of deep learning model that can generate images, and these show promise in helping solve this computational problem. We used GANs to generate synthetic tomograms, and through further developments, these synthetic tomograms can be used to speed up training for CNNs and to spark developments in biomanufacturing, vaccine development, and cancer research.

We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. We also attest that the above properly reflects our own work.

Team Leader's Signature:_____ Date:_____

Team Member 1's Signature:_____ Date:_____

Team Member 2's Signature:_____ Date:_____

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with your Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**