Colorado Science and Engineering Fair

2025 Individual 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: Enhancing Brain Tumor Classification with Synthetic Data via Gen Models & Hybrid Training

Finalist's Name: Devang Pandey

School and City: Fairview High School, Boulder, CO

Sponsor's Name: Nolan Robert Brady

Category: Mathematics & Computer Sciences

Division: Senior (grades 9 - 12)

Abstract (250 words or less):

With over 330,000 new cases diagnosed annually worldwide, brain tumors present a significant global health challenge. Unfortunately, many patients face a prolonged diagnostic process, waiting weeks to months for a definitive diagnosis–time that many cannot afford to lose. Additionally, the disorganized landscape of neuro-oncology datasets poses challenges, as many datasets are either too large to process efficiently or too small to provide meaningful insights. This research explores how synthetic data can enhance classification accuracy in brain tumor diagnosis. Classification models, including Google Vision Transformer and Microsoft ResNet50, were evaluated across three experimental variants: a baseline using real data, a synthetic testing set, and a split-training approach combining synthetic and real data with real validation and testing sets. Additionally, two generative models–Generative Adversarial Network (GAN) and Google's Denoising Diffusion Probabilistic Model (DDPM)–were tested to determine which could generate higher-quality images and enhance classification performance. The GAN-generated images exhibited a higher Frechet Inception Distance (FID) across all classes except the no-tumor class (132.48-194.04), indicating lower image fidelity than DDPM (171.64-252.07). In variant 2, the ResNet50 model achieved 85.66% accuracy with GAN images and 23.46% with DDPM, while the Vision Transformer reached 97.77% with GAN and 25.51% with DDPM. Additionally, increasing synthetic samples enhanced ResNet50 accuracy by 20%, while the Vision Transformer remained steady at 99.63%, showing no significant impact. By utilizing synthetic imaging and computational models, this research emphasizes a promising avenue for more efficient and accessible AI-driven brain tumor diagnostics.

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

Finalist'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 you Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**