Cross-Modal Knowledge Transfer for Mental Rotation Tasks

IIT Bombay Internship Project — **Team ByteBuzz (T1_G21)**

■ Project Overview

This project focuses on Cross-Modal Knowledge Transfer using multimodal physiological and behavioral data collected from 38 postgraduate students during Mental Rotation Tasks.

The goal is to build teacher–student models where the EEG modality (teacher) transfers knowledge to student modalities (Eye-tracking, GSR, Facial expressions) using techniques like Knowledge Distillation, Domain Adaptation, and Contrastive Learning.

■ Repository Structure

• data/: Processed dataset (EEG.csv, GSR.csv, EYE.csv, IVT.csv, TIVA.csv, PSY.csv)
• notebooks/: Jupyter notebooks for Steps 1–5
• results/: Trained models, figures, metrics
• Project_README.pdf: Detailed report (internship submission)
• README.md: GitHub README

■ Workflow

Step 1: Preprocessing & Feature Extraction

• EEG band powers
• GSR peaks/slope
• Eye-tracking pupil/gaze
• IVT fixations/saccades
• TIVA emotion features
• PSY (ResponseTime, Difficulty, Verdict, Label
• PCA reduction

Step 2: Baseline Single-Modality Models

• EEG teacher (XGBoost)

• Eye, GSR, TIVA student baselines (RandomForest)

Step 3: Teacher □ Student Knowledge Transfer

• Knowledge Distillation with hard + soft labels

Step 4: Domain Adaptation & Contrastive Learning

• Adversarial alignment across modalities

• Contrastive positive/negative pairs

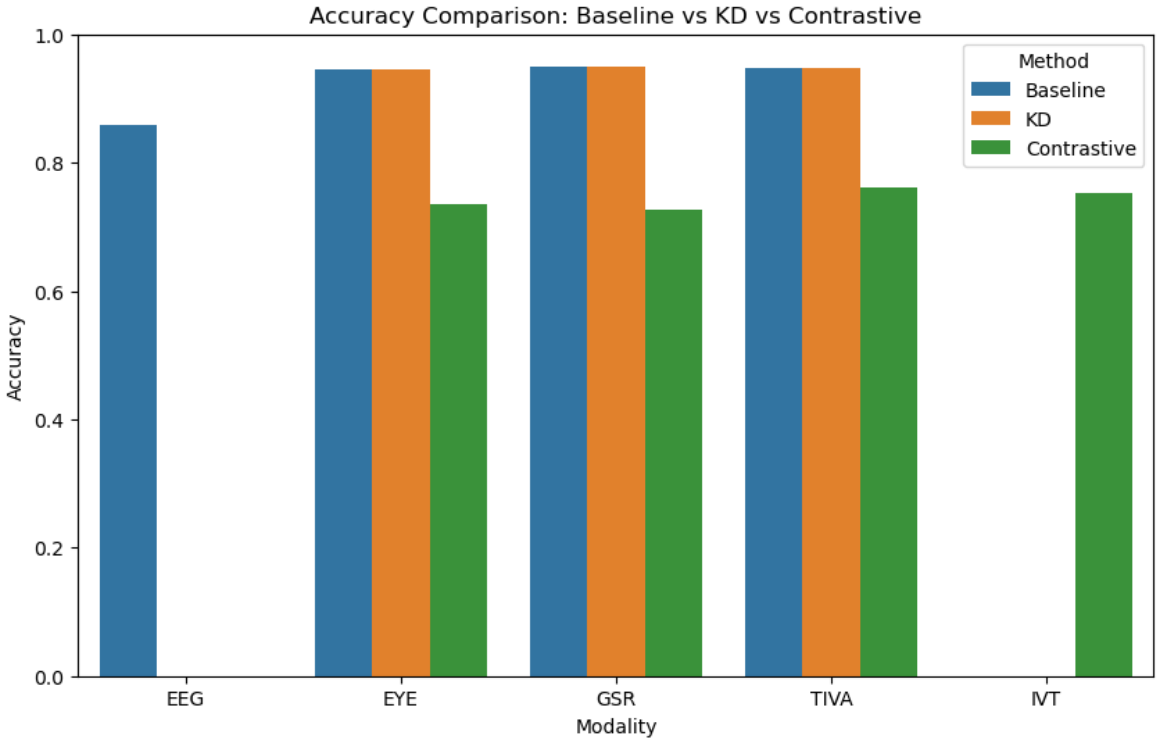
Step 5: Evaluation & Interpretation

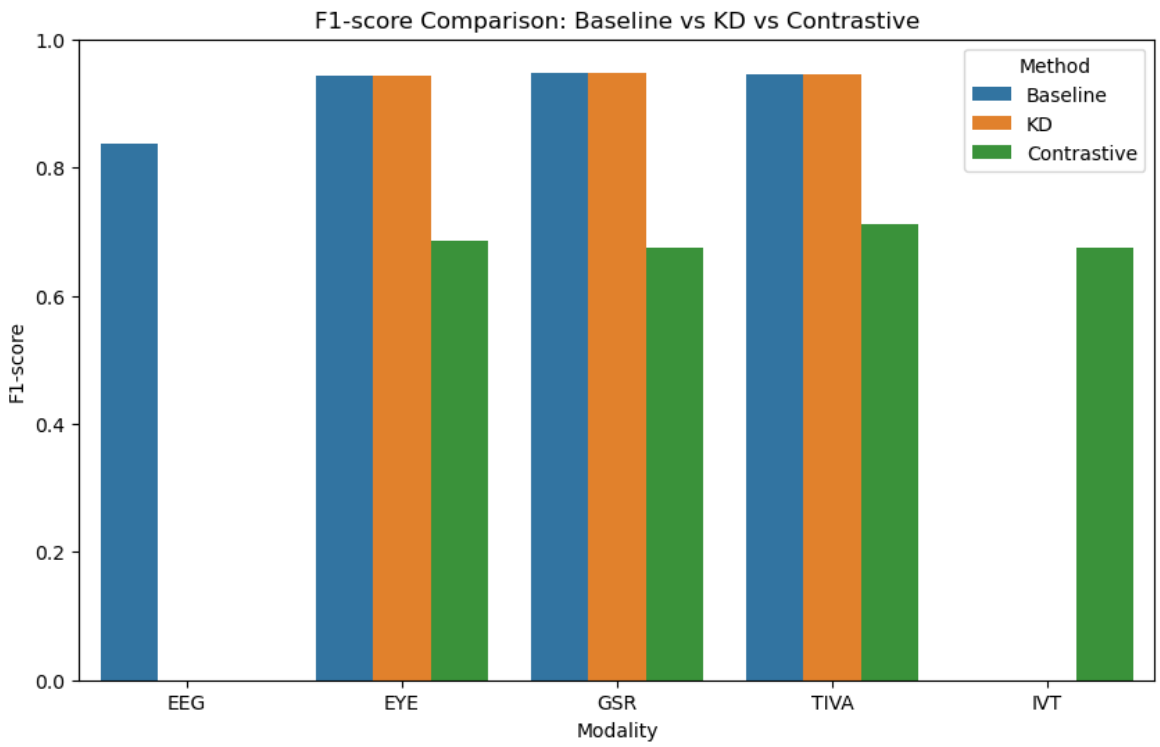
• Metrics (Accuracy, F1-score)

• Visualization of results

• Interpretation of modality importance

■ Key Results





• ■ GSR achieved the best F1-score

• ■ EEG + KD improved students

■ Requirements

• Python 3.9+

• Jupyter Notebook

• Libraries: pandas, numpy, scikit-learn, xgboost, matplotlib, seaborn

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■ Running the Project

1. Clone repository

2. Download student data from given drive link.

3. Open Jupyter Lab

4. Run notebooks in order (01 -> 05)

■ Team ByteBuzz (T1_G21)

This project was developed as part of the IIT Bombay Internship Program.