# Insights Report – Polygon UNet Assignment

## 1. Introduction

The objective of this assignment was to develop a deep learning model that, given an **outline image of a polygon and a color name**, generates a **filled polygon image**.
Two models were implemented:

1. **Image-only UNet**
2. **Color-conditioned UNet**

## 2. Dataset

The dataset consists of:

- Polygon outline images as inputs
- Corresponding filled-color polygon images as outputs
- Metadata in data.json

It is divided into **training** and **validation** splits.
The dataset includes multiple polygon shapes (triangle, square, star, pentagon, hexagon, octagon, diamond, circle) with different colors.

## 3. Models and Architecture

**1. Image-only UNet**

- **Input:** Outline image of a polygon
- **Output:** Predicted filled polygon image

**2. Color-conditioned UNet**

- **Input:** Outline image + one-hot encoded color vector
- **Output:** Predicted filled polygon image in the specified color

The color-conditioned UNet includes additional input channels to incorporate the color information explicitly.

## 4. Hyperparameters

- **Learning Rate:** 1e-3
- **Batch Size:** 16
- **Epochs:** 20
- **Loss Function:** MSELoss
- **Optimizer:** Adam

## 5. Experiment Tracking

All experiments were tracked using **Weights & Biases (wandb)** for:

- Monitoring training and validation losses
- Comparing model performances

- Saving best model checkpoints

**Image-only model run:**
https://wandb.ai/soumoofficial2004-techno-institute-of-engineering-and-ma/polygon_unet_assignment_imgonly/runs/bq0kn3hy

**Color-conditioned model run:**
https://wandb.ai/soumoofficial2004-techno-institute-of-engineering-and-ma/polygon_unet_assignment_conditioned/runs/y0puvi45

## 6. Results

**Validation Loss:**

- **Image-only UNet:** ~0.0367
- **Color-conditioned UNet:** ~0.0360

The color-conditioned UNet consistently outperformed the image-only model. Predictions were **more accurate and color-consistent**.

## 7. Key Learnings

- Adding **color conditioning significantly improves accuracy**.
- Automatic color detection from JSON ensures flexibility and prevents issues such as KeyErrors.
- **UNet architecture works effectively** for image-to-image translation.
- **wandb** made it easy to track experiments and compare results.

## 8. Future Improvements

- Use **data augmentation techniques** (rotation, scaling, flipping) to improve generalization.
- Experiment with **perceptual loss** (VGG-based) for sharper results.
- Explore **transformer-based architectures (ViT/UNet hybrid)** for even better performance.

**Additional Links**

- **GitHub Repository:** https://github.com/Soumodip04/polygon-unet-assignment