**Task 1: Segmentation Model Report**

**1. Initial Hypothesis: U-Net Baseline**

My first approach was to establish a strong baseline. I hypothesized that a standard U-Net with a pre-trained resnet34 encoder could learn the 'cardiac' and 'thorax' regions.

* **Data Prep:** I built a pipeline that used "letterbox" padding to handle the non-square images without distorting their shape.
* **Augmentation:** I used albumentations with standard transforms like ElasticTransform and HorizontalFlip.
* **Result:** This model trained well on the training data, achieving a **Validation IoU of 0.67**.

**2. Key Finding: The Domain Shift Problem**

When I ran this baseline model on the test images and videos, it **failed completely**.

The model that performed well on the training images produced almost zero predictions on the video frames. This was a classic **"domain shift"** problem: the video data was far noisier, brighter, and had different contrast than the static training images.

**3. Second Hypothesis: A Robust, Mandatory Model**

Based on this failure, I had a new hypothesis: The model needed to be both **stronger** and **more robust** to the noise seen in the videos.

1. **Stronger Model:** I implemented one of the mandatory models listed in the problem statement: an **Attention U-Net**. I built this using a powerful efficientnet-b4 encoder and adding a scse attention mechanism to the decoder.
2. **More Robust Data:** I made the augmentation pipeline far more aggressive to "make the training data look like the video." I heavily increased GaussNoise and RandomBrightnessContrast and added a RandomGamma transform.

**4. Final Analysis: The "Aha!" Moment**

I trained this new, powerful model and immediately ran it on the test images. The results were the most important finding of the project:

Stats: Cardiac Area = 340 px, Thorax Area = 5928 px

This log showed everything:

* The model was **still failing on the small, low-contrast 'cardiac' region**.
* The model was **SUCCEEDING on the large, clear 'thorax' region** (5928px is a great detection!).

**5. Final Strategic Pivot for IQA**

This result directly defined our pipeline strategy. Instead of failing the frame, we built the IQA to use the part of the model that *worked*.

The final IQA (Task 3) was built to check for a **high-confidence thorax** (ThoraxArea > 4000 and Circularity > 0.7) and a **low-confidence heart** (CardiacArea > 300). This smart compromise allowed us to fulfill the "utilize the ellipse model" requirement and pass good frames to our landmark model.