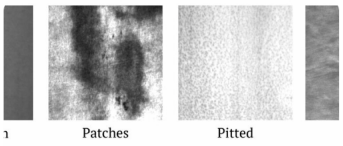
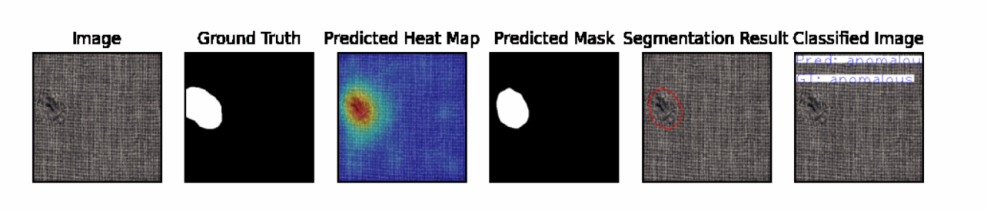
Business Case Assignment: Transfer Learning for Visual Quality Control

Company Background – VisionIQ
VisionIQ builds computer vision solutions for smart factories. They rely on pre-trained CNNs to speed up development for detecting visual defects in production lines, given limited labeled data and diverse product domains.



https://www.kaggle.com/datasets/fantacher/neu-metal-surface-defects-data



https://www.kaggle.com/code/ipythonx/mvtec-ad-anomaly-detection-with-anomalib-library

Objective
Apply Transfer Learning techniques using real-world datasets to:
- Build an initial binary classifier
- Improve it using data augmentation and fine-tuning
- Adapt it to a new visual domain with minimal rework
- Communicate findings from a business lens

TASK 1 — Baseline Transfer Learning (25%)
Use Case: Classify defective vs. non-defective parts.
Dataset: metal-defect-detection (Kaggle)
Instructions:
- Load MobileNetV2 with include_top=False, weights='imagenet'
- Freeze all base layers
- Add your custom classification head
- Train for 5–10 epochs
- Plot accuracy and loss
Deliverables:
- Code (.ipynb)
- Plots (acc/loss)
- 150-word business explanation

TASK 2 — Data Augmentation to Improve Robustness (25%)
Use Case: Improve generalization to lighting/angle changes on the factory floor.
Dataset: metal-defect-detection (Kaggle)
Instructions:
- Use tf.keras.layers for RandomFlip, RandomRotation, RandomZoom, Rescaling
- Retrain the frozen model from Task 1
- Compare accuracy and loss with and without augmentation
Deliverables:
- Updated code
- Side-by-side training curves
- 150-word explanation

TASK 3 — Fine-Tuning the Model (25%)
Use Case: Improve accuracy further by retraining part of the base model.
Dataset: metal-defect-detection (Kaggle)
Instructions:
- Unfreeze the last 20 layers of MobileNetV2
- Use a lower learning rate (e.g., 1e-5)
- Retrain for 5–10 more epochs
- Compare performance before and after fine-tuning
Deliverables:
- Updated training script
- Metrics table and curves
- 150-word note

TASK 4 — Domain Adaptation to New Product Line (25%)
Use Case: Classify bottle defects from a new production line
Dataset: MVTec Bottle Anomaly Detection
Instructions:
- Load your Task 3 model
- Replace dataset with “bottle” images
- Fine-tune on this small dataset
- Compare domain transfer performance
- Reflect on scalability of your approach
Deliverables:
- Final code
- Metrics table (metal vs. bottle)
- 200-word strategic note

Rubric (Applied Across All Tasks)

Criterion	Excellent (5)	Good (3–4)	Poor (1–2)
Model functionality and logic			
Business-grounded reflections			
Clean code, modularity, readability			
Visualizations (accuracy/loss)			