


Project : Breast Ultrasound Image Segmentation & Classification

We're seeking to develop a multi-task U-Net to analyze the Breast Ultrasound Images Dataset. Your goals are to preprocess the data, implement the model from scratch, train both segmentation and classification tasks jointly, and evaluate performance. Below is a simplified outline:

Team Formation

Each team will consist of a maximum of **4** members. The editable link to the team creating sheet is provided below. Form your teams and write your names+IDs.

Section 01:  [CSE428-01] Lab Project Teams.xlsx

Main Tasks to Do

1. Dataset Review & Preprocessing [[Breast Ultrasound Image Dataset](#)]

- **Understand the data:** Read the linked paper given in the website to learn how scans were acquired and annotated.
- **Explore files:** Inspect image formats, folder structure, and annotation files.
- **Preprocess images:**
 - Resize and normalize pixel values.
 - Apply noise reduction or morphological filters as needed.
 - Parse and verify lesion masks and image-level labels.

2. Model Design: Multi-Task U-Net [[Idea of raw U-Net](#)] [[Idea of Multi-Task based U-Net](#)]

- **Shared encoder** (contracting path) to extract feature maps.
- **Segmentation head:** U-Net style decoder with skip connections to produce pixel-wise masks.

- **Classification head:** Global pooling at the bottleneck followed by one or more fully connected layers to predict image labels (normal, benign, malignant).
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3. Training Strategy

- **Loss functions:**
 - Segmentation: Dice loss or cross-entropy.
 - Classification: Cross-entropy.
 - Combine into a weighted sum (e.g., $\alpha \cdot \text{SegmentationLoss} + \beta \cdot \text{ClassificationLoss}$).
 - **Optimization:**
 - Joint backpropagation for both heads.
 - Use learning-rate scheduling, early stopping, and appropriate batch sizes.
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4. Evaluation Metrics

- **Segmentation:**
 - Mean Intersection over Union (mIoU)
 - Dice coefficient
 - Pixel accuracy
 - **Classification:**
 - Accuracy
 - Precision, recall, F1-score
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5. Bonus Task (Optional) [[EfficientDet: Scalable and Efficient Object Detection](#)]

- Replace the U-Net decoder with a BiFPN (from EfficientDet) for multi-scale feature fusion.
 - Re-run training and compare segmentation and classification results before vs. after.
 - Analyze any improvements or trade-offs.
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