CSC 480 Project Proposal: Airbus Ship Detection Challenge

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Competition Description

The Airbus Ship Detection Challenge on Kaggle involves identifying ships in satellite imagery by generating accurate segmentation masks. This task is particularly difficult due to cloud cover, haze, varying ship sizes, and complex environments like harbors or open seas. The evaluation metric is the F2 Score, calculated across a range of intersection-over-union (IoU) thresholds from 0.5 to 0.95. This work has real-world applications in maritime surveillance, where rapid and accurate ship detection can help address threats such as piracy, illegal fishing, and environmental hazards.

Dataset

The dataset consists of over 190,000 satellite images, each 768×768 pixels in size. Many images contain one or more ships, while others contain none. The ground truth labels are provided in run-length encoding (RLE) format, which efficiently represents binary segmentation masks. The diversity in lighting conditions, weather, and geographic location increases the difficulty of the task and will require robust preprocessing and modeling strategies.

ML Problem Formulation

I will formulate this task as a binary semantic segmentation problem, where each pixel is classified as either "ship" or "background". The RLE-encoded masks will be decoded into binary masks and resized to a manageable resolution (384×384). Images and masks will be serialized into TFRecord files for efficient data loading. I will also apply extensive data augmentation using the Albumentations library to increase model generalizability.

To tackle this problem, I plan to implement and compare the following deep learning architectures:

- **ResUNet**: A variation of U-Net with residual connections that improves gradient flow and helps stabilize training.
- **U-Net++**: An advanced segmentation model that introduces nested skip pathways for better feature fusion.
- **Attention U-Net**: Enhances U-Net with attention gates that focus the model's attention on important spatial features.

These models will be trained using mixed-precision training for efficiency and evaluated based on the F2 Score, Dice Coefficient, and IoU metric. The final output masks will be thresholded and encoded back into RLE format for submission to Kaggle.

Action Plan

- **Weeks 9–10: Data Preprocessing and Setup**
  - Decode RLE masks and preprocess images (resizing, normalization).
  - Generate TFRecord files for training and validation sets.
  - Apply augmentations such as flips, fog, and cropping.
- **Week 11: Baseline Model Implementation**
  - Implement and train the ResUNet architecture.
  - Monitor training with custom loss functions and validation metrics.
- **Week 12: U-Net++ and Attention U-Net**
  - Implement U-Net++ and Attention U-Net architectures.
  - Compare results against ResUNet using the same data pipeline.
- **Week 13: Evaluation and Model Selection**
  - Evaluate models on the validation set using the F2 score.
  - Perform ablation studies and fine-tune key hyperparameters.
- **Week 14–15: Final Submission and Report Writing**
  - Generate test set predictions and format submission CSV files.
  - Write the final project report with visualizations, results, and key findings.
  - Reflect on challenges and potential future work.

Potential Pitfalls and Alternatives

Key challenges may include class imbalance (many images without ships), GPU memory limitations when working with large images, and models that overfit due to small datasets. If initial approaches do not perform well, I will explore lightweight architectures, deeper regularization, or use ensembles of multiple models. Additionally, alternative data formats (like HDF5) may be considered if TFRecords present performance issues.

Citation

inversion, Jeff Faudi, and Martin. *Airbus Ship Detection Challenge*. 2018. Kaggle. `https://www.kaggle.com/competitions/airbus-ship-detection`