Project Planning Report
SSY340 Deep Machine Learning

Planning Group 50
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1. Problem Statement & Motivation

We aim to develop a deep learning model for classifying intracranial hemorrhages (ICH) from CT scans, focusing on subtypes: epidural, intraparenchymal, intraventricular, subarachnoid, and subdural. This is compelling as ICH is a medical emergency requiring rapid diagnosis, yet radiologist shortages delay care and an AI tool could provide initial triage, potentially saving lives in resource-limited settings. We expect to achieve high accuracy on balanced subsets, demonstrating feasibility for clinical integration.

We'll use the RSNA ICH dataset from Kaggle (2019 competition), comprising ~874,000 CT slices from 25,000+ scans across 21,000 patients, totaling ~500GB in DICOM format. Labels are per-slice for six classes (binary multi-label). For computational feasibility, we'll subsample ~10-20% of data, ensuring class balance (e.g., equal positive/negative instances) via stratification. Preprocessing stacking slices into "triplets" (3 consecutive slices as 3-channel inputs) to capture volumetric context. These images can then be put together to get a volume of a patient's entire brain. This requires some preprocessing, and will most likely also require some normalisation as the images from different hospitals use different machines and parameters for imaging.

2. Implementation

Both pairs will work on the same dataset/problem but differ in implementation: one emphasises ResNet-50 for feature extraction from triplets, followed by RNN (e.g., LSTM) for sequence classification across patient volumes. The other pair uses Vision Transformers (ViTs) for end-to-end feature learning and FCNN for classification, allowing comparison of CNN vs. transformer efficacy on sequential data.

The Kaggle competition already hosts numerous kernels, including top solutions like an EfficientNet-based keras baseline model and ensemble models. Instead of 2D slice-wise classification, we'll implement triplet stacking and sequence modeling (RNN/FCNN on feature maps), adding a novel "sum-of-products" aggregation for complex multi-slice decisions. This extends baselines to handle volumetric dependencies, absent in most available codes.

3. Relevant papers

- Chang et al. (2018): Hybrid 3D/2D CNN for Hemorrhage Evaluation on Head CT Scans, inspiring our triplet approach (https://www.ajnr.org/content/39/9/1609).
- Ye et al. (2019): Ye et al. (2019): Precise diagnosis of intracranial hemorrhage and subtypes using a three-dimensional joint convolutional and recurrent neural network, for subtype classification (https://pubmed.ncbi.nlm.nih.gov/31041565/).
- Arbabshirani et al. (2018): Advanced machine learning in action: identification of intracranial hemorrhage on head CT, motivating clinical impact (https://www.nature.com/articles/s41746-017-0015-z).
- Kuo et al. (2019): Expert-level detection of acute intracranial hemorrhage on head computed tomography using deep learning, using similar datasets (https://www.pnas.org/doi/10.1073/pnas.1908021116).

4. Evaluation

We'll use multi-label metrics: weighted log loss (competition standard), AUC-ROC per class, precision, recall, F1-score, and confusion matrices to evaluate our models. Cross-validation (5-fold) on subsets (proper train/validation/test splits) and compare against baselines and other pair's results for ablation studies on architecture choices. If time permits we would also like to compare our volumetric-based approach against a conventional approach using just 2D slices to evaluate the effectiveness of our approach.

5. Time plan

Project work begins after planning report submission on October 9, 2025, with poster PDF and report due by October 24, 2025 (aiming for alignment with poster deadline).

- October 10-13: Data subsetting, preprocessing, triplet creation.
- October 14-17: Implement ResNet/RNN models, train baselines.
- October 18-20: Evaluation, comparisons, ablation.
- October 21-24: Report writing, poster preparation, refinements.